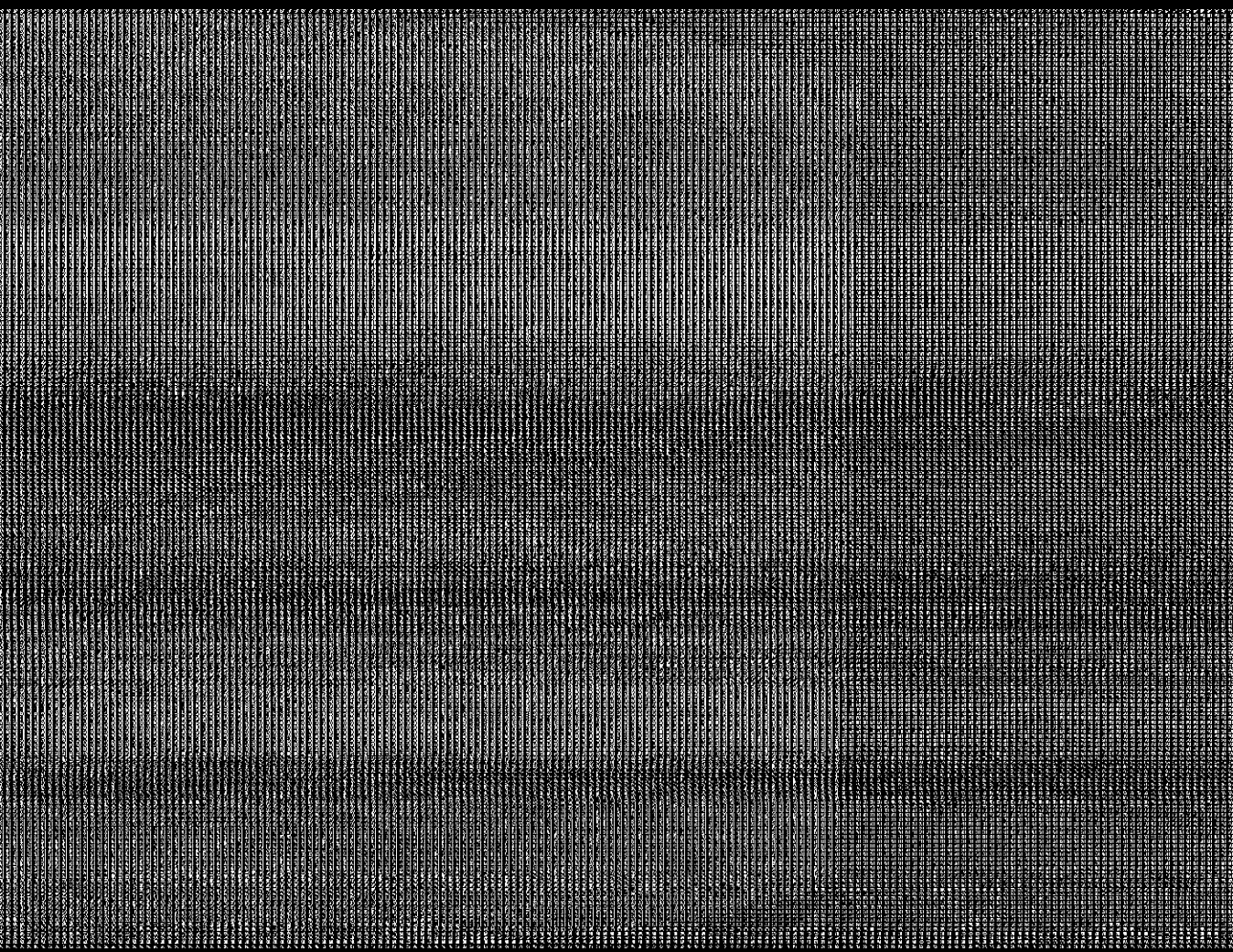

EFFECT OF THE SMALL WATERSHED PROGRAM ON MAJOR USES OF LAND: EXAMINATION OF 60 PROJECTS IN THE SOUTHEAST, MISSISSIPPI DELTA, AND MISSOURI RIVER TRIBUTARIES REGIONS. By C. Dudley Mattson. Economic Research Service, U.S. Department of Agriculture. Agricultural Economic Report No. 279.

ABSTRACT

Land use changes in 1955-70 on sample areas with installed P.L. 566 Small watershed improvement projects are compared with sample areas having planned but undeveloped projects, using aerial photographs.

Cropland retirement on upland portions of watersheds was more rapid on completed projects than on new ones in the Southeast and Mississippi Delta regions. In the Mississippi region, cropland expansion on protected bottomlands of installed projects was well ahead of the rate of planned projects. In the Southeast, cropland expansion failed to take place. Cropland retirement, typical for the region, also failed to take place. In the Missouri River tributaries region, there was no significant change in the predominant cropland use of both upland and bottomland areas after project installation. Widespread increases in soil-conserving practices were noted on all projects studied in the Missouri River tributaries region.

Planners anticipating land use changes from project development should consider additional factors that could modify the expectations of benefited landowners, such as (1) likely available capital and labor for land conversions, (2) size and organization of farm enterprises, and (3) long-term demands for crops suited to climate, soils, and configurations of benefited areas.

Keywords: Small watershed projects, land use, development, flood protection, drainage, irrigation, projections, benefits.

Washington, D.C. 20250 February 1975

PREFACE

The Small Watershed Program of the Soil Conservation Service (SCS) is a multiproject water resource development program. SCS early recognized the importance of ex post studies and has supported the Economic Research Service (ERS) in such studies since the beginning of the program.

Ex post studies are important to the orderly progress of multiproject water resource development programs because individual projects are justified on the basis of estimates and assumptions about future events. The performance of projects in influencing resource use consistent with expectations should be checked periodically. There is a correlary need to develop improved methods for predicting the consequences of project development. It is hoped this study will assist in achieving these goals.

The author is indebted to Thomas Frey and Henry Dill for their suggestions and help in planning this study. Henry Dill, now retired from ERS, completed all of the photo interpretation under contract to ERS.

The latest photos available were used to determine land use changes that have taken place. Aerial surveys are carried out about every five years.

Cover photo courtesy of Soil Conservation Service

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In 1954 Congress authorized the Watershed Protection and Flood Prevention Program with passage of P.L. 83-566. Purposes emphasized in the law were the improvement of soil conserving practices on headwater drainage areas and a reduction of water problems on flood plains. The goal was to achieve more productive and efficient use--from a long-range view--of project lands. The program is based on local initiative with Federal technical and financial assistance to solve locally identified problems through group action.

The Soil Conservation Service of the USDA, administering the program, provides technical guidance in developing project work plans. The evaluation process includes an appraisal of expected changes in the use of project lands made possible by the project. Flooding and drainage problems of flood plains and erosion of uplands are lessened by project development. The consequent changes in land use are expected to result in reduced soil losses from uplands and increased income from the use of flood plains.

The purpose of this study was to determine the land use changes associated with project installation in three regions of the country. Groups of 10 installed projects were compared with similar sets of 10 new projects in each of three regions of the country. The time period of change was approximately 1955-70. Aerial photographs of each project taken at the beginning and end of the period were compared and changes recorded for eight land uses: cropland, grassland, idle-transitional, forest, urban, rural-urban, miscellaneous, and reservoirs.

In the Piedmont area of the Southeast, typical problems were erosion of upland fields and frequent flooding of bottomlands. Planners expected that project installation would result in conversion of cropland to permanent grass or forest in the uplands, and expansion of cropping on the narrow flood plains. This study found that on the small, mostly noncommercial farms, owners failed to provide the labor and capital to reclaim flood plain areas. On the uplands, there was considerable conversion of cropland to forests on completed projects, less on new project areas.

In the Mississippi Delta region, excess standing water on flat land was the main problem. Extensive areas of hardwood forests have been cleared and converted to cropland, following the regional trend of recent years. Commercial agriculture has been expanding rapidly since World War II. Project installation in Arkansas seems to have speeded forest clearing. Undeveloped project areas, mostly in Louisiana, were being converted to cropland almost as rapidly, however. In the Delta, 17 of 20 small watershed projects were made feasible by major drainage and flood control work carried out by the Crops of Engineers. Patterns of change on upland areas were similar to those observed in the Southeast region.

In the Missouri River tributaries region, where commercial agriculture has occupied about 86 percent of the land for some time, erosion control of hilly, loess soils was the main purpose for project installation. Watershed development has resulted in little or no changes in major land use patterns, although there appears to be an increase in soil conserving practices such as contour and minimum tillage, terracing, grassed waterways, and increased use of sod in rotations. Installed project measures apparently have helped reduce erosion and gully enlargement.

Present projections of land use changes resulting from project installation rely heavily on stated intentions of farmers, and on land use capability and soil productivity. This study indicates that other factors should be considered as well. These include increased off-farm employment opportunities, available farm labor, supplies of labor and capital to carry out land use conversions, and long-term trends for crops suited to local climate and soils and the developing patterns of farm size and organization.

Effect of the Small Watershed Program on Major Uses of Land

Examination of 60 Projects in the Southeast, Mississippi Delta, and Missouri River Tributaries Regions

by C. Dudley Mattson*

INTRODUCTION

The Small Watershed Program was authorized by Congress in 1954 with passage of P.L. 566, the Watershed Protection and Flood Prevention Act. It was developed to complement other Federal programs of water management by addressing problems of watershed protection in headwater areas, and flooding and related water management problems of small streams. The program is restricted to watersheds of 250,000 acres or less. Projects are initiated by local groups, who are assisted by the Soil Conservation Service in planning works of improvement, jointly funded by local agencies and the Federal Government. Project measures may include a variety of land treatments, dams, channel clearing or realignment, floodways, and other similar measures to manage the flow of water.

This program aims at improving efficiency in the use of the Nation's flood plains as well as reducing soil losses from erodible lands. These purposes imply that both uplands and flood plains would frequently undergo changes in the ways they were used as a result of flood control, drainage, or erosion control measures. Most flood control measures were expected to require group action, with the Federal Government providing major financing. Drainage and erosion control were to be accomplished by combinations of group action (where several properties were affected) and individual efforts. Both kinds of measures are jointly financed by the Federal Government and local groups or individuals. Measures to achieve these objectives are described in detail in work plans approved for each project area.

The achievement of benefits from flood control, drainage, and erosion control depends, first, on the installation of planned measures and, second, on efficient and soil conserving uses of the affected lands. The first results from group action implementing the plan. The second depends on individual landowners' decisions, not specified in work plans.

Planners for watershed projects are required to evaluate expected benefits from project development as part of the feasibility study. They are charged with anticipating the expected flow of benefits far into the future--even up to the

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100-year expected life of some structures. Since this flow of benefits depends in part on the decisions of individual landowners regarding use and management of affected lands, this job of prediction is beset with considerable uncertainty. Many factors, not clearly foreseen, may influence land use decisions in addition to the expected changes in the water regime promised by project development. Thus, planners need all the help and experience available in attempting to predict future uses of project lands as a step toward evaluating future benefits.

In this study an attempt is made, by comparing land use changes on completed projects with land use changes on similar new ones, to identify changes which may be project related and those which may have resulted from other factors. Where other factors appear to be important in explaining land use changes, suggestions are offered to planners for estimating these changes to be expected from future watershed project development.

STUDY DESCRIPTION

Purpose and Objectives

This study identifies and quantifies major changes in land use generated by landowners in response to small watershed project development. Specific objectives were to:

1. Measure changes among major land use categories on completed watershed projects for three representative regions of the United States east of the Rocky Mountains. Changes were recorded separately for "benefited areas" 1/ and the remainder.

2. Measure the land use changes over the same time period for comparable new (undeveloped) project areas in the same regions.

3. Compare and analyze changes on completed versus new projects in each region.

Approach and Procedure

The approach was dictated by the purpose of the study and available time and resources. Aerial photograph interpretation was considered the only feasible means for determining land use change on sample projects totaling more than 2 million acres. The following criteria were selected as a basis for determining regions for study and sample projects:

1. Regions must contain one or more land Resource Areas (LRA's) exhibiting related topographic and soil conditions and comparable land use patterns. 2/

2. A minimum of 10 projects, completed 5 or more years before latest available photography, in each of three regions.

3. Completion considered adequate for study purposes if 80 percent or more of Federal obligations were reported by cutoff date (5 years before latest available photos of area).

1/ Areas shown on project work plan maps to be benefited by structural measures, principally flood plains downstream from dams, lowlands adjacent to and drained by constructed or improved channels, or both.

2/ Land Resource Areas are designated by the Soil Conservation Service. As defined in (7, p.2), Land Resource Areas "consist of geographically associated land resource units, characterized by particular patterns of soil (including slope and erosion), climate, water resources, land use, and type of farming." (Number in parentheses refers to reference list at end of text.)

4. Ten recently approved, comparable projects in each region having no structures in place at the time of recent photography.

5. Choice of sample projects confined to those with similar water-management problems primarily affecting agricultural land.

These criteria limited the choice to four regions. One was studied and recently reported by Sloggett (5). The other three concentrations of completed and new projects were further screened by use of the Land Resource Area map and the related publication of SCS (7). The intent was to confine the samples, if possible, to one or more contiguous LRA's exhibiting either related problems and land use patterns or similar soil conditions, or both. The three regions used were the Southeast, the Mississippi Delta, and the Missouri River tributaries (Mo-trib). Figure 1 shows location of the 60 sample projects and pertinent LRA's.

Selection of Sample Projects

The sample projects were selected by starting with the oldest completed project in each region, coming forward in time, and selecting all projects that met the above criteria. In only two cases were projects passed over because of atypical problems--urban flood damage. The recent projects that qualified were chosen by beginning with the most recently authorized and progressing back in time until the sample of 10 was identified.

In a few cases it was difficult to find completed projects that met the 5 or more years cutoff after 80 percent of Federal fund obligations. One project in the Southeast was installed 4 years before photos, three in the Delta were installed 3 years before photos, and one in the Mo-trib region was installed 4 years before photos. The average time intervals after completion for the three groups selected were: Southeast, 6.2 years; Delta, 5.7 years; and Mo-trib, 7.5 years.

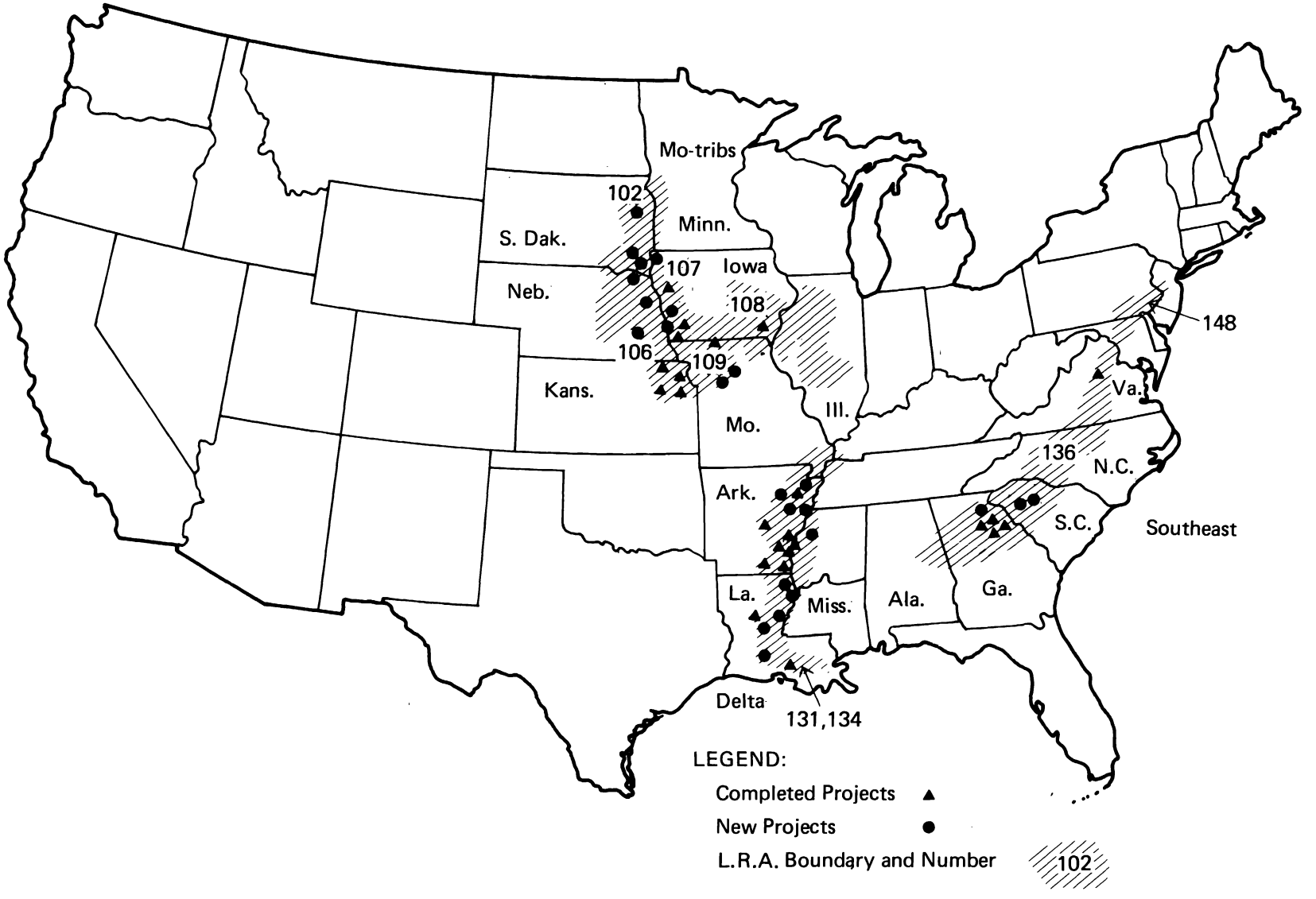
Southeast

This group is in the Piedmont portions of Virginia, South Carolina, and Georgia. Although LRA's 136 and 148 are in different Land Resource Regions, they share many characteristics of topography, land use, and water-related problems. The one sample project in LRA 148 (Virginia) was similar in many ways to the remaining 19 projects in South Carolina and Georgia, and all lie in the Piedmont Regions. The common problems were flooding and erosion.

Mississippi Delta

The Delta group includes areas in Arkansas, Mississippi, and Louisiana. All projects lie in the Mississippi Delta Cotton and Feed Grain Land Resource Region. Except for some of the upland, all benefited areas are within the Southern Mississippi Valley Alluvium Area (LRA 131). Combined drainage and flood prevention were the characteristic problems.

Figure 1. Sampled P.L. 566 Watershed Projects and Land Resource Area Locations



Missouri River Tributaries

The Mo-trib group includes the loessal hills along the tributaries in South Dakota, Nebraska, Kansas, Iowa, and Missouri. All but 2 of the 20 projects are in the contiguous LRA's 102, 106, and 107. The other two are in adjoining LRA's 108 and 109. Eighteen of the projects drain into the Missouri River; the other two drain into the Mississippi River. The unifying characteristics of this group are the presence of rolling to hilly land covered with loessal and intermingled till soils. The common problems were erosion and flood damage, in that order.

Photo Interpretation of Land Use Change

The 60 project areas total some 2 2/3 million acres. Choice of available photography was directed to the smallest scale that would provide resolution suitable for interpretation. Because of numerous small areas needing separate interpretation, it was determined that 100 percent examination by dot grid would be used for land use estimates. Photo coverage from the Agricultural Stabilization and Conservation Service was available at approximately 5-year intervals. These photos were purchased in index sheets with a scale of about 1 inch = 1 mile. 3/ This scale and resolution has been found acceptable on similar studies of land use change (2).

Boundaries of watershed projects and benefited areas were placed on late photos by use of project work plan maps. In order to identify land use changes, early and recent photos were examined in concert. 4/ All changes were then coded directly on the recent photo sheets. Dot grids with 40 dots per square inch were used to apportion the acreage of benefited area and the remainder among the several uses. The acreage given in work plans was used to apportion the dot counts among the following defined land uses.

Cropland--Includes: (1) fields identifable by tone, texture, and shape as planted to or being prepared for crops, (2) other fields characterized by sharp corners and distinct boundaries and lack of large vegetation, and (3) areas recently cleared.

Grassland--Consists of open areas generally maintained but lacking evidence of recent tillage. Distinguished from idle-transitional by smoother appearance, darker and more even tone, presence of some water source, and usually scattered shade trees. Additional evidence includes paths, trampled areas, and stock ponds.

Idle-transitional--These areas formerly in crop production are characterized by irregularly distributed brush and small trees, indefinite field borders and

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3/ Index sheets are photos of assembled contact prints forming an uncontrolled mosaic with approximate scale of 1:63,360.

4/ Dates of photos used are given in appendix tables 1-3. They covered intervals of 11-19 years.

corners, and uneven tone. Land classified idle-transitional appears to be reverting to forest; however, the term is used to denote the existing situation rather than to forecast future use.

Forest--Areas predominantly covered with trees, including fairly young stands.

Urban--Urban places, industrial sites, mining operations, institutions, airports, golf courses, race tracks, drive-in theaters.

Rural-urban--Farmsteads, small villages.

Miscellaneous--Roads, small streams and ponds, ditches, gravel pits, railroads, power and pipeline rights-of-way.

Project reservoirs--Areas covered by permanent water pools behind project structures. Does not include land taken for damsites.

FINDINGS

Since the major purpose of this study was to compare the land use changes on completed and new watershed projects, a number of characteristics of each regional group were examined for similarities and differences.

Southeast

Project Areas and Planned Development

The projects studied in this group, both completed and new, are remarkably alike in many ways. The topography is typically gently to strongly hilly, with elevation differences of 200-600 feet, occasionally more. Benefited areas comprise 3-8 percent of project areas. They are narrow, linear flood plains, one-fourth to one-half mile wide and 3-6 miles long. Project purposes were heavily dominated by flood protection and control of erosion-siltation. A few projects also included water supply development.

The characteristic structural measures used were flood control reservoirs, with channel improvements downstream. On some projects, multiple-purpose reservoirs included water supply with flood control. Land treatment measures planned with landowners emphasized reduction of erosion through establishment of permanent vegetative cover on steeper slopes and erodible soils. Permanent grass or woodland uses were encouraged.

Land Use Patterns

The major ownership of both completed and new projects in the Southeast was in private farms, 85 percent and 73 percent, respectively. The remainder was accounted for by urban land and land in public and corporate ownership, mostly forest. The average size of farms reported in work plans was 119 acres for completed projects (1955-60) and 139 acres for new projects (1965-69). In both periods the farms were described as predominantly noncommercial--yielding sales of less than $2,500 per year. Cropland and grassland-pasture each averaged about 25 percent of the completed project areas, according to work plan estimates. For new projects, work plans reported 9.4 percent in cropland and 18.9 percent in grassland. The largest single use in both groups was forest: 45 percent on completed projects and 60 percent on new ones. 5/

Farming activities described in both sets of work plans included livestock (beef and dairy) and supporting feed crops of corn and soybeans as expanding activities. Cotton, once the dominant crop, has all but disappeared. Recently completed project areas showed some increase in poultry production and a few

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5/ Data in work plans rarely provided breakdowns of land uses separately for benefited areas. Thus it was not feasible to compare photo interpretations directly with plan data.

sizable beef herds. The modest difference in farm size between completed and new projects reflected the general trend of increasing farm size reported by the Agricultural Census for 1954 versus 1969. For the counties embracing these 20 projects, the 1954 average farm size was 89 acres; in 1969 it was 167 acres. (The average planning date interval between completed and new projects was 10.8 years.) The most notable difference between completed and new projects was the average size: 26,000 acres and 56,000 acres, respectively. This reflected the program trend toward larger scale projects. (4)

Expected Results of Project Development

Projects in the Southeast were designed to reduce flooding of bottomlands and soil erosion from the uplands. Planners generally anticipated reduced cropping of uplands and some increased crop production on protected bottomlands. On the typical completed watershed, land once cropped and now idle because of flooding was expected to return to intensive use as cropland or improved pasture. Benefits were estimated from this restored productivity, intensification of land use, and changed land use. The latter was usually expected to take the form of small clearings of woodland areas that were suitable for the expansion of fields or pastures. Intensified use was expected to result from increased fertilization of crops and pastures and the conversion of native to improved and managed pastures. Collectively, these are called land enhancement benefits.

Table 1 summarizes selected benefits, as reported in project work plans. For the completed projects the sample of 10 is compared with 32 in LRA's 136 and 148. For incomplete projects the 10 new sample plans are compared with 63 projects being installed. Damage reduction benefits record the gains to existing land uses from flood reduction. All remaining benefits are credited to other purposes. The large difference in damage reduction between the sample and the 32 completed projects reflects a preponderance (74 percent) of benefits for purposes other than flood prevention. This trend toward other water development benefits has continued, and is reflected in the data on incomplete projects.

Recalling that the two samples drawn represent the oldest and newest projects, it is evident there has been a general decline in the percent of benefits claimed for land enhancement. The decline is almost entirely accounted for by restoration of land to its former productivity, partly offset by increased benefits in the other categories. During the life of the program, the scale of projects has increased steadily so that these enhancement benefits have increased in absolute value per project, though not as rapidly as other benefits, notably for recreation and other water supply purposes.

Changes in Land Use on Sample Areas

The two Southeast samples, 10 each of completed and new projects, were examined for land use changes on benefited areas (bottomlands) and separately on the remaining (upland) areas. The sample projects differed in size; completed projects averaged 26,087 acres, new ones 55,932 acres. The benefited areas (bottomland) on completed projects averaged 1,278 acres, 4.9 percent of the total watershed; benefited areas on new projects averaged 2,303 acres, 4.1 percent of the total. Figures 2 and 3 present data on the sample uplands and sample benefited areas, respectively, in terms of percent of each.

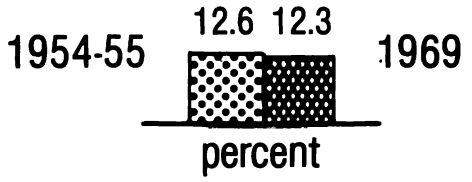
Table 1--Expected benefits for completed and incomplete watershed projects, Southeast region

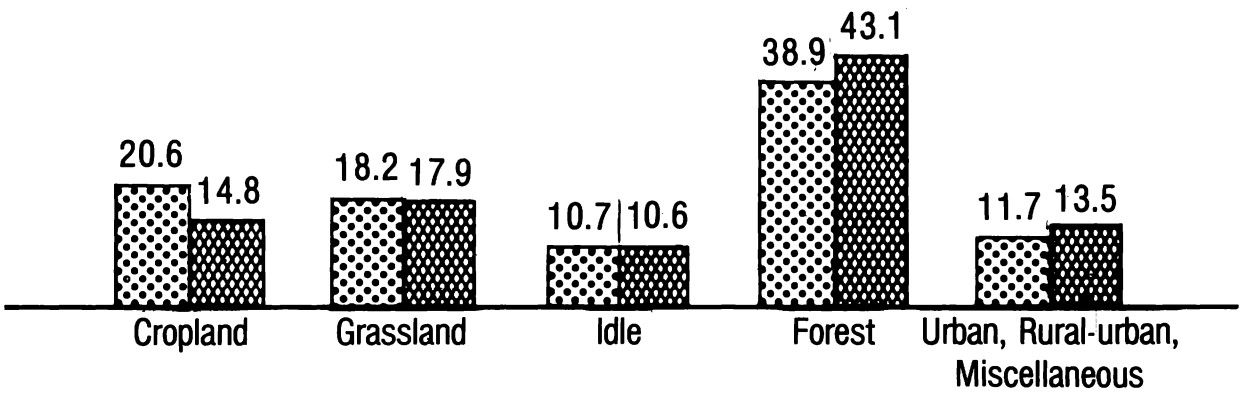
Benefits	Completed projects		Incomplete projects	
	Sample of 10	Total in LRA's (32) 1/	Sample of 10 (new)	Total in LRA's (63) 1/
	Percent of total benefits			
Total damage reduction	76.58	35.99	25.78	27.19
Land enhancement:				
Restoration of productivity 2/	(24.30)	(22.13)	(6.33)	(7.19)
More intensive land use	8.25	5.82	16.38	9.98
Changed land use, agricultural	0	1.22	.37	.34
Changed land use, urban	0	0	0	6.76
Total land enhancement	32.55	29.17	23.08	24.27
Drainage	0	0	0	0
Irrigation	0	.19	0	.62
Benefits from all other purposes	15.17	56.78	57.47	55.11
Total benefits	100.00	100.00	100.00	100.00

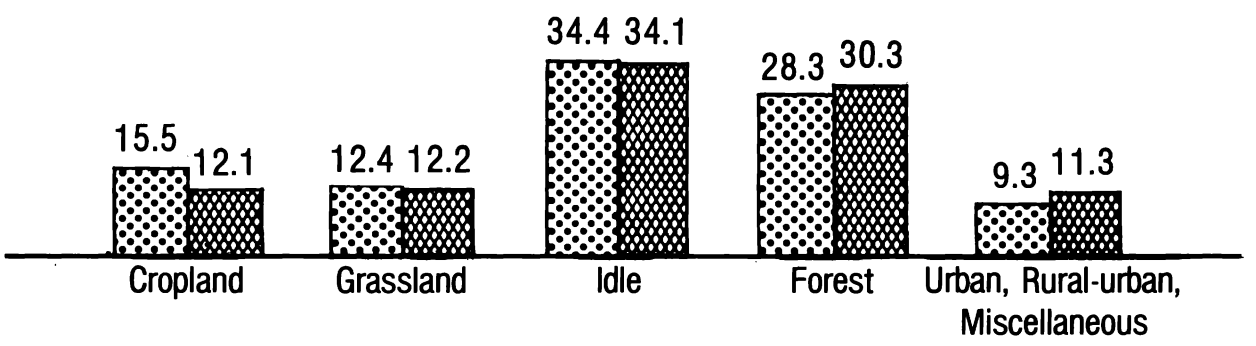
1/ Land Resource Areas (LRA's) 136 and 148. Numbers in parentheses refer to the number of projects.
2/ Included in flood damage reduction.

Source: Watershed work plans published by the Soil Conservation Service, USDA.

Figure 2. Land Uses on Southeast Upland Areas, 1954-55 and 1969*

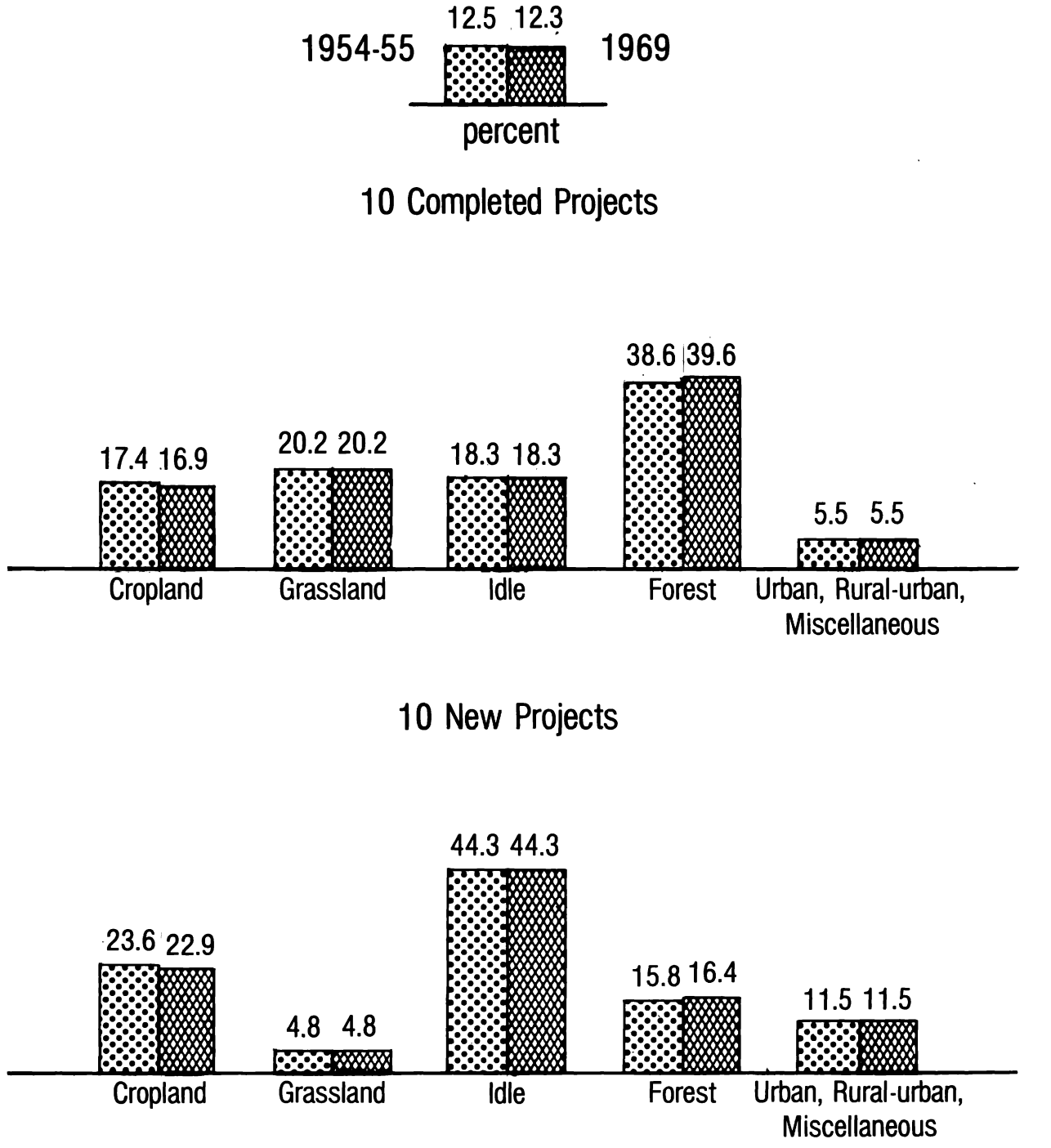






* Change interval for completed projects averaged 14.2 years (1955-69); for new projects it averaged 15.2 years (1954-69).

Figure 3. Land Uses on Southeast Benefited Areas, 1954-55 and 1969*



* Change interval for completed projects averaged 14.2 years (1955-69); for new projects it averaged 15.2 years (1954-69).

In comparing the original (early) land uses of the two samples (completed and new projects), it appears that agricultural activity is more intensive on completed than on new projects. On both uplands and benefited bottomlands, the area in crops and grass is about 11 percentage points greater on completed than on new projects. On the other hand, there was 2 1/2 to 3 times as much idle-transitional land on new projects as on completed ones. Since this land was formerly cropped or pastured, there was apparently a marked decline of intensive agricultural use on these new projects prior to 1954. Completed projects showed a consistently higher percent of forested land than new projects, especially on the bottomland. The remaining land use categories listed require no comment, since no large differences were revealed.

Changes in land use differed for upland and benefited areas in the Southeast. For upland areas, figure 2 shows major changes in cropland and forest on both completed and new projects. Completed projects showed a decrease in cropland of .406 percent per year, nearly twice the decrease of .224 percent for new projects. 6/ Increases in forest and urban categories almost equaled cropland losses; remaining uses were essentially stable over the interval.

Figure 3 reveals an unexpected picture--very little change in any land use on benefited areas. There were slight losses of cropland and expansion of forest. There is no indication that the idle-transitional land has been restored to former productivity, as plans anticipated. Figures 2 and 3 show net change in nearly all land uses. While most changes represent simple shifts in various categories, all in the same directions, a small number of multiple shifts took place. There were small shifts from forest to crops or pasture and from forest to urban or reservoir use. The total upland involved in change was 20,346 acres (8.2 percent) on completed projects; 31,153 acres (5.8 percent) on new projects. The net changes in upland for the two samples were plus and minus 15,024 acres (6.1 percent) and plus and minus 24,410 acres (4.6 percent) on completed and new projects, respectively. The small changes recorded on bottomlands were consistent, simple shifts except for one new project, where 20 acres of forest were cleared for cropping.

Mississippi Delta

Project Areas and Planned Development

The Delta projects selected for study shared several major characteristics. All had large, flat lowlands, subject to frequent flooding and poor drainage. For most project areas there was little physiographic relief from lowest to highest point. The major problems were combined flood control and drainage. Channel development and improvement were the principal structural solutions for most projects. Seventeen of the 20 projects were made feasible by prior or planned work of the Corps of Engineers, consisting of major channel construction sometimes combined with levee building. Land treatments emphasized land leveling, open and tile drainage of fields, and cultural practices to improve internal soil drainage. Erosion control measures were planned on uplands where needed.

6/ For completed projects: -5.76 percent ÷ 14.2 years = -.406 percent per year; for new projects: -3.40 percent ÷ 15.2 years = -.224 percent per year.

Benefited areas constituted over half of the total area for most projects. The major difference encountered between the two samples was again project size. New projects were more than three times the size of old projects, and their benefited area was 4 1/3 times as large. Another difference related to the sequence of development of P.L. 566 projects within the study area. Eight of the 10 completed projects are in Arkansas, near the northern end of the area. 7/ Of the new projects, half are in Arkansas-Mississippi and half in Louisiana. As explained below, this required partial analysis of the northern and southern projects separately because of strikingly different patterns of land use and change. A second highly variable characteristic among projects was the amount and type of the nonbenefited area. For two old and four new projects the entire area benefited. At the other extreme, for one project in each sample, less than 10 percent of the area benefited. Thus the analysis of land use change on these nonbenefited areas is complicated by their varied nature and extent.

Land Use Patterns

Intensive agriculture is the dominant land use for nearly all of the 20 Delta projects. Cash crops, especially cotton and soybeans, dominate. The following observations apply particularly to the bottomland portions of all projects, whether benefited by project development or not. Before development, pasture was a minor use of bottomland and was rarely important on the upland. Other crops cultivated on some projects included rice, wheat, sugarcane, corn, poultry, beef, and truck crops. Bottomland forests were often described as poorly stocked and managed. On most of the recent projects, bottomland forests were being cleared at a rapid rate except for tracts (on three Louisiana projects) owned by timber companies. On one new and one old project, wooded upland was a major land use.

Except for corporate timbered tracts, most of the land is owned by individual resident farmers. Projects planned in the late 1950's reported average farm size of 191 acres. Projects planned during the mid- to late 1960's reported average farm size of 274 acres. Upland farms were typically much smaller, subsistance-type units, with some farm abandonment reported. A few farms with extensive bottomlands, operated by employed managers, were much larger than the average. Since benefited areas on new projects average 77 percent of total area, versus 56 percent on old projects, this difference amplified the farm size difference. Average planning dates for sample projects were about 1960 (completed) and 1967+ (new), for an average difference of 7.5 years. According to the Census of Agriculture reports for the 27 counties (parishes in Louisiana) in which these 20 projects are located, farm size averaged 93 acres in 1954, 310 acres in 1969. The trend to larger farms began before the older sample plans were prepared, and is continuing.

7/ Frey and Dill, (2), describe the early progress of land clearing for crop development in Arkansas, compared with Louisiana. This development no doubt led to earlier identification of problems requiring the small watershed approach than occurred in Louisiana.

Expected Results of Project Development

The major problem common to these Delta projects was the persistence of water on agricultural land after frequent, heavy rains. As described in most plans, problems of flood control and drainage are inseparable. Exceptions are one early and two recent projects. On one early Louisiana project, agricultural benefits were entirely from irrigation. The area was already receiving flood protection from Corps of Engineers levee construction. Two new Arkansas projects were planned for flood protection only.

The major benefits identified in all projects were expected to result from increased crop yields and quality, and reduced production costs. Some increase in agricultural land was expected to result from clearing of woodland, though in most cases this was expected even without project installation. For projects with distinct uplands, land use patterns were expected to be stable, with some shifts from crops to grassland pasture. The nonbenefited flatlands generally resembled the benefited areas, though "not needing drainage." They were expected to undergo the same shifts from forest to cropland. All recent plans described the continuing conversion of bottomland forest to cropland, principally for soybean production. Plans developed during the 1950's seldom recognized this possibility. During that period, cotton was the major crop. There was little evidence of cropland expansion, and planners were aware of the Department of Agriculture's policy against encouraging expansion of acreage for price-supported crops--cotton, corn, rice, and wheat.

Table 2 compares selected benefits summarized from work plans for four groups of Delta projects. These were expected by planners to accrue to the benefited areas--the protected bottomlands. Of the total 47 projects approved for development (fig. 1), construction was completed on 22 by July 1972; 25 were still incomplete. The two samples of 10 projects each reflect the earliest and most recent planning. Our interest is focused on the land enhancement benefits and on the relation of total damage reduction to drainage benefits. The only serious departure of sample projects from the larger group averages occurred for intensified land use benefits and for irrigation on early project. The irrigation benefits were explained above by the atypical Louisiana projects. Benefits from land use changes for agriculture are not large for any group.

Changes in Land Use on Sample Areas

Projects in the two Delta samples averaged much larger than those in the Southeast. Completed projects averaged 33,500 acres and new ones, 107,000 acres. Benefited areas, as mapped in project plans, included only parts of some bottomlands. Thus, the nonbenefited areas included uplands together with partial bottomlands on these projects. On two completed and four new projects, the entire watershed area was expected to benefit. Thus the two samples of nonbenefited area included eight completed and six new projects, respectively.

Benefited areas averaged 18,939 acres or 56.4 percent for completed and 82,334 acres or 77.0 percent for new projects. Figures 4 and 5 show land use in 1957 and 1970 for sample benefited and nonbenefited areas. 8/ Because of the large

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8/ The average dates of photos for both samples were 1957 and 1970, with an average interval of 12.7 years.

Table 2--Expected benefits for completed and incomplete projects, Mississippi Delta region

Benefits	Completed projects		Incomplete projects	
	Sample of 10	Total in LRA's (22) 1/	Sample of 10 (new)	Total in LRA's (25) 1/
	Percent of total benefits			
Total damage reduction	36.72	34.99	46.30	32.89
Land enhancement:				
Restoration of productivity 2/	(9.09)	(6.52)	0	(.95)
More intensive land use	4.76	11.93	3.14	13.00
Changed land use, agricultural	2.10	1.48	.18	1.51
Changed land use, urban	0	0	0	0
Total land enhancement	15.95	19.93	3.32	15.46
Drainage	29.56	44.85	30.82	26.34
Irrigation	17.55	0	0	3.35
Benefits from all other purposes	9.31	6.75	19.56	22.91
Total	100.00	100.00	100.00	100.00

1/ Land Resource Area (LRA's) 131 and 134 in the Mississippi Delta Cotton and Feed Grain Region. Numbers in parentheses indicate number of projects covered.

2/ Included in flood damage reduction.

Source: Watershed work plans published by the Soil Conservation Service, USDA.

Figure 4. Land Uses on Mississippi Delta Nonbenefited Areas, 1957 and 1970

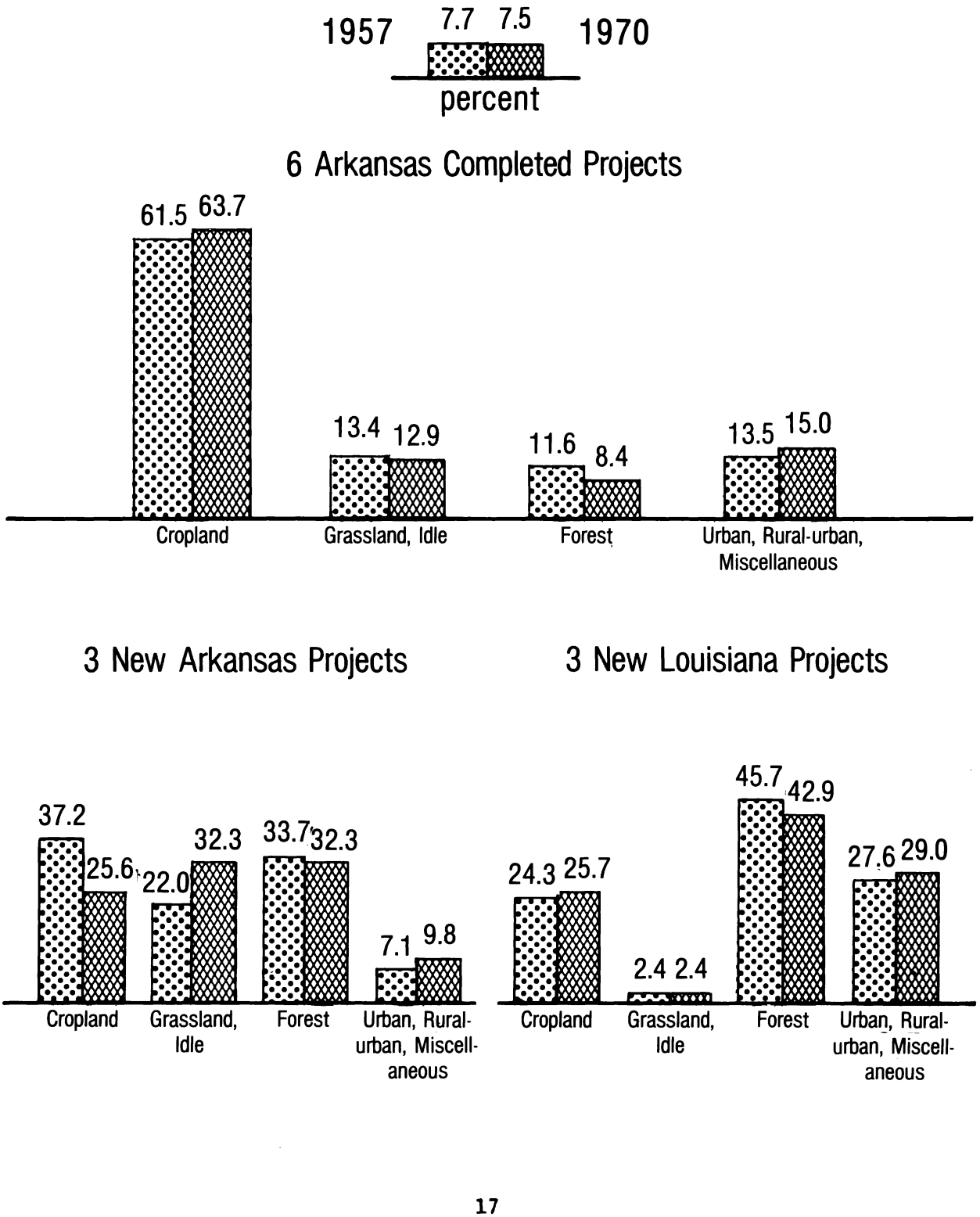
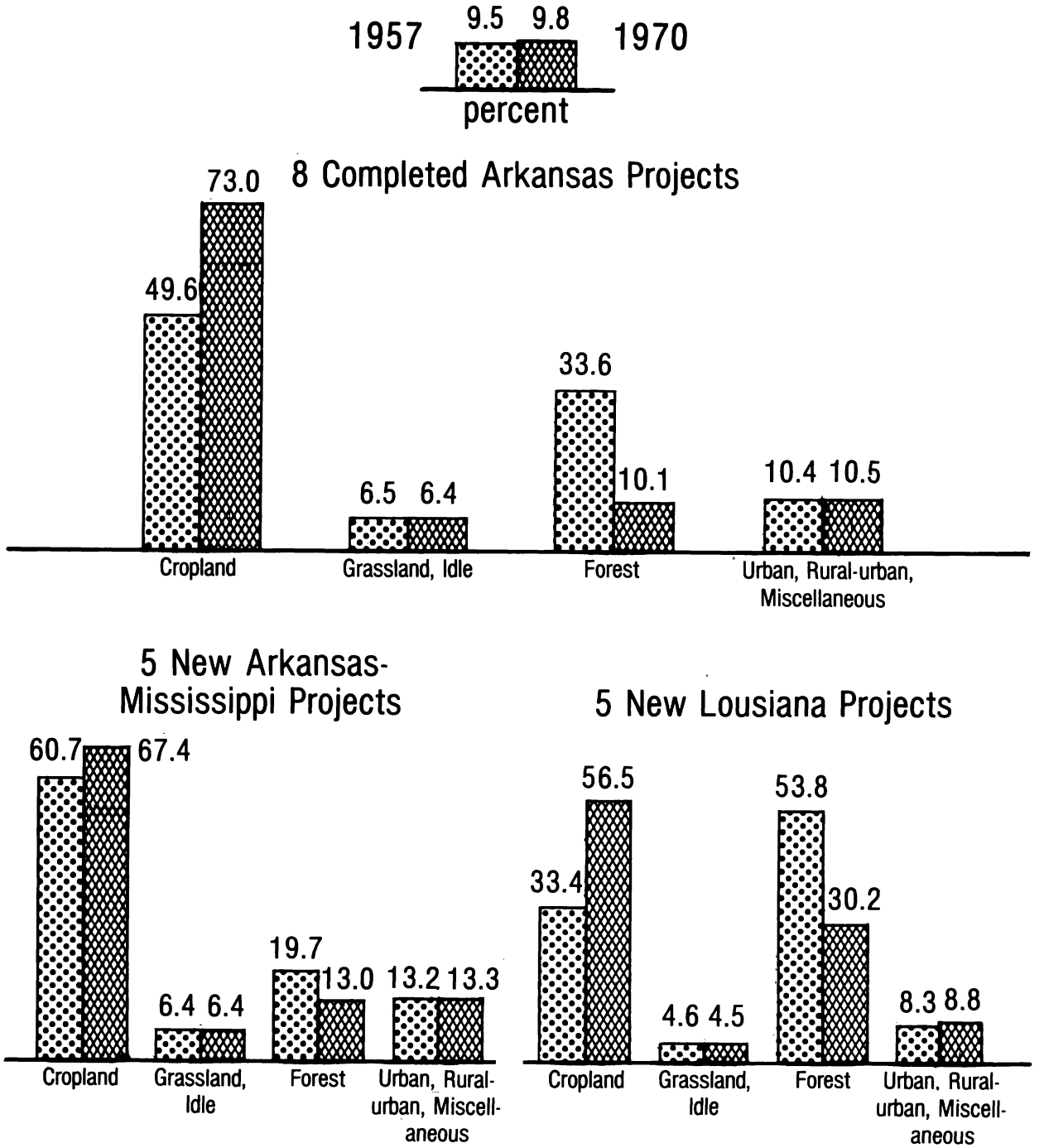


Figure 5. Land Uses on Mississippi Delta Benefited Areas, 1957 and 1970



differences in the land use patterns of northern (Arkansas and Mississippi) versus southern (Louisiana) projects, both new and completed projects were analyzed separately for the two subareas.

Nonbenefited areas--Uses of land outside the benefited areas present a mixed picture when aggregated for these samples. Only eight completed and six new projects have some nonbenefited area. In each group, some land is upland and some is bottomland, with proportions varying among projects. Figure 4 shows land uses for the seven Arkansas completed projects. The one completed project in Louisiana was omitted since it was atypical, with over 90 percent of the area in upland, mostly national forest. This project accounted for three-fifths of the total nonbenefited area in the sample.

The nonbenefited area on completed Arkansas projects was four-fifths bottomland; 75 percent of this nonbenefited area was already in agricultural use. Thus, land use changes were expected to parallel those in the benefited areas. Cropland increased modestly as did urban land, at the sacrifice of the small remaining forest land. The net gain for agriculture was 1.7 percent. Other changes were minor.

Nonbenefited areas of three projects in Arkansas and three in Louisiana were analyzed separately. In Arkansas the nonbenefited area, totaling about 104,000 acres, was 90 percent hill land; in Louisiana, the 142,000 acres were entirely bottomland.

In Arkansas, agricultural uses maintained nearly 60 percent of total nonbenefited area, but with a marked drop in cropland of 11.6 percentage points. The offsetting gain in grassland was 10.3 percentage points. Forest land maintained about one-third of the total area. Urban use and reservoirs (planned) gained about equal amounts, accounting for 2.7 percent of the total.

On new Louisiana projects, nonbenefited areas showed a 2.8 percent loss in forest area, contributing to small net gains in urban and cropland uses. Cropland provided most of the area for urban expansion, while forest clearing provided for cropland gains. The two lower graphs in figure 4 show changes that are consistent with both (a) benefited areas in the Delta bottomlands (see next section) and (b) upland areas in the Southeast. The trend on hilly upland is toward less intensive use, with crops shifting to grassland. Trends on bottomland, protected or not, are toward more intensive use as cropland. (Appendix tables 8 and 20 give detailed data on land use changes.)

Benefited areas--The dominant land use of benefited areas on completed Delta projects was agriculture--58 percent in 1957 (idle-transition land was negligible). Forest was the only other major use, occupying 31 percent of these bottomlands. On most of these projects, drainage work had been started by small group efforts in 1911-30. During the 1950's and continuing into the 1960's, the Corps of Engineers and State agencies were enlarging the systems of main channels. This work provided outlets for the smaller channels to be reclaimed or installed on these early small watershed projects. (Appendix tables 9 and 21 give detailed data on land use changes.) Figure 5 shows land uses in 1957 and 1970 for three groups of sample projects. The eight Arkansas completed projects show the most dramatic displacement of forest by cropland, about 23.4 percent in 13 years. Other land uses are practically unchanged.

By 1970, agriculture occupied 73 percent of the land. The benefited area of these eight projects totals 157,000 acres.

About 114,000 acres were benefited on the five new Arkansas-Mississippi projects; 60.7 percent of this area was in cropland, compared with 49.6 percent in 1957 for completed Arkansas projects. The rate of conversion of forest to cropland was much slower (6.7 percent in 13 years); the remaining forest area was larger for new than for completed projects. Other uses--grassland, idle, urban, and miscellaneous--were practically unchanged over the interval.

The five new projects in Louisiana had a total of 710,000 benefited acres, more than six times the area benefited in the other five new projects. In 1957, these benefited areas were one-third cropland and over half forest. Other uses were minor, totaling about 13 percent. The rate of conversion of forest to cropland almost exactly matched that of the completed projects; however, forests still occupied about 30 percent of these bottomlands in 1970.

The Arkansas-Mississippi projects have probably reached a fairly stable land use pattern. Agriculture occupied 80 percent of completed and 74 percent of these new project bottomlands in 1970. The five new Louisiana projects, with 61 percent of benefited areas in agriculture, still had about 214,000 benefited acres (30 percent) in forest. An added 61,000 acres of bottomland forest (non-benefited) could be cleared for agriculture. The SCS work plans (about 1967) for three of the Louisiana projects reported 142,000 acres of forest industry ownership, mostly in benefited areas. If these lands are continued in wood production, less than 20 percent of these project areas may remain for conversion to cropland. 9/

Net Land Use Changes for Entire Project Area

Looking at the two subareas as a whole, the five new Arkansas-Mississippi projects show a small net loss of cropland, all from the uplands. Cropland in the completed Arkansas projects increased from 51.9 percent of the total watersheds (1957) to 71.7 percent (1970). The only comparable Louisiana completed project (all area benefited) showed trends comparable to the Arkansas projects, though the changes were less dramatic--about 3 percent of the project area shifted from forest to cropland. Cropland increased from 31.6 percent (1957) to 51.0 percent (1970) in the five new Louisiana projects.

Missouri River Tributaries Region

Project Area and Planned Development

The projects selected in the Mo-trib region were alike in a number of characteristics. The topography was typically moderate to steeply hilly, with

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9/ Personal communication on July 31, 1973, with Bob Johnson, U.S. Forest Service, Stoneville, Miss., indicates that forest industries are generally maintaining their lands in wood production, although some land may be cleared and replanted to young trees.

predominantly loess soils in the uplands and deep alluvium deposits on the small flood plains. Completed projects averaged about 22,000 acres; new projects, 24,500 acres. For most projects, flood plains occupied less than 10 percent of total area. Benefited bottomlands given flood protection averaged almost 7.0 percent of completed projects and 5.6 percent of new projects. Two of the completed projects had no flood-protected bottomlands. Typical problems on all projects were erosion, both gully and sheet, and flood damage. Sediment was a correlary problem, identified but usually not evaluated for estimated damages.

Problem solutions emphasized land treatments for erosion control. Many project plans reported good to excellent progress by farmowners in establishing contour tillage, terraces, grass waterways, crop rotations with several years of perennial grass, and strip cropping. Problems needing group action centered on gully control, requiring structural measures. Typical structures include small grade-stabilizing dams, sometimes combined with flood-retarding capacities. Sediment problems were primarily associated with filling of reservoirs and channels. A few multiple-purpose reservoirs were planned to provide recreation water. Drainage problems were minor, confined mostly to the extensive flatlands on the South Dakota projects (three new ones).

Land Use Patterns

Almost the entire ownership on these 20 Mo-trib project areas was in commercial farms. The only minor departures were: one new project embracing 4,500 acres of an Army ordinance depot; and two old projects embracing 3,400 acres of urban land. According to the Agricultural Census, farm size in the counties that contained these projects averaged 210 acres in 1954 and 282 acres in 1969. The weighted averaged size of farms reported for completed plans was 185 acres (about 1958); for new plans, 221 acres (about 1969).

Crop production on these farms was almost entirely feed grains, with corn and soybeans dominant. Farm incomes came principally from livestock production, mostly beef cattle and hogs. Small amounts of grain were sold in local markets. Dairying was locally important on a few projects. Farms were described as prosperous, commercial, and mostly owner operated. Tenant farming accounted for up to 35 percent of some project areas.

Expected Results of Project Development

With few exceptions, the Mo-trib projects were expected to greatly reduce soil loss from erosion. The most serious damage was land voided by advancing gullies. Of expected benefits evaluated, erosion control ranged from zero (on flood reduction projects) to 97 percent, averaging close to 50 percent of total damage reduction benefits.

Land enhancement benefits were expected on a number of early (completed) projects, resulting from intensified or changed land use. These benefits were expected on flood plains (usually) and on reclaimed and graded gullies. Benefits in these categories were rarely claimed for new projects.

Table 3 shows expected benefits for the two sample groups and for all projects in the relevant LRA's. In all cases, benefits from damage reduction, whether from flood prevention or erosion control, dominated the benefits expected. Land enhancement benefits were less than 10 percent of totals. The change in land use expected on the sample of completed projects was always toward cropland, out of grass or woodland.

Changes in Land Use on Sample Areas

The Mo-trib region has been intensively farmed for many decades. The soils are highly fertile, with few hindrances to crop or grassland cultivation. The original forests have mostly disappeared. Thus, there is little opportunity for further expansion of cultivation, especially in view of the erosion problems described above.

Figures 6 and 7 show the distribution of land uses and changes revealed on air photos from the mid 1950's to 1970. Figure 6 shows that land used for producing crops and livestock accounted for about 87 percent of uplands on both completed and new projects. The latter show about 7 percent more cropland and correspondingly less grassland than the completed projects.

There was virtually no idle land identified on the Mo-trib projects. The remaining four categories shared almost equally the residual 13 percent, with little difference evident between old and new projects.

Land use patterns on benefited bottomlands (fig. 7) followed a pattern similar to that on uplands. The only irregularity was the percent of forest on completed projects, initially 12.2 percent compared with 2.7 percent on the uplands (fig. 6). Most of this land use was found on two of the seven projects providing flood plain benefits.

The patterns of land use on all of these project areas were remarkably stable over the 14-15 year interval. Only two sources of change had any significant effect on land uses recorded during the 1950's--urban development and project reservoirs. (In order to compare completed and new projects for changes resulting from reservoir building, the areas of planned reservoirs on new projects were identified and changes were recorded as if the reservoirs were completed.) Reservoir building accounted for most of the change on new projects, and shared equally with urban growth on completed ones. One new project experienced a single, large second-home development, which accounted for nearly all of the gain in urban area for these projects. Four completed projects experienced growth of urban centers, two of them increasing 15-30 percent in area over the 15 years.

Cropland increased in three old and one new project, all at the expense of forest area. However, these gains were more than offset by losses. All but one of the forest conversions (110 acres on a completed project) were on upland areas. There were no recorded cases of gains in grassland area.

While major land use categories remained stable, changes were evident in the methods of managing cropland on upland areas. The resolution of photos used in this study did not permit accurate assessment of the widespread installation of

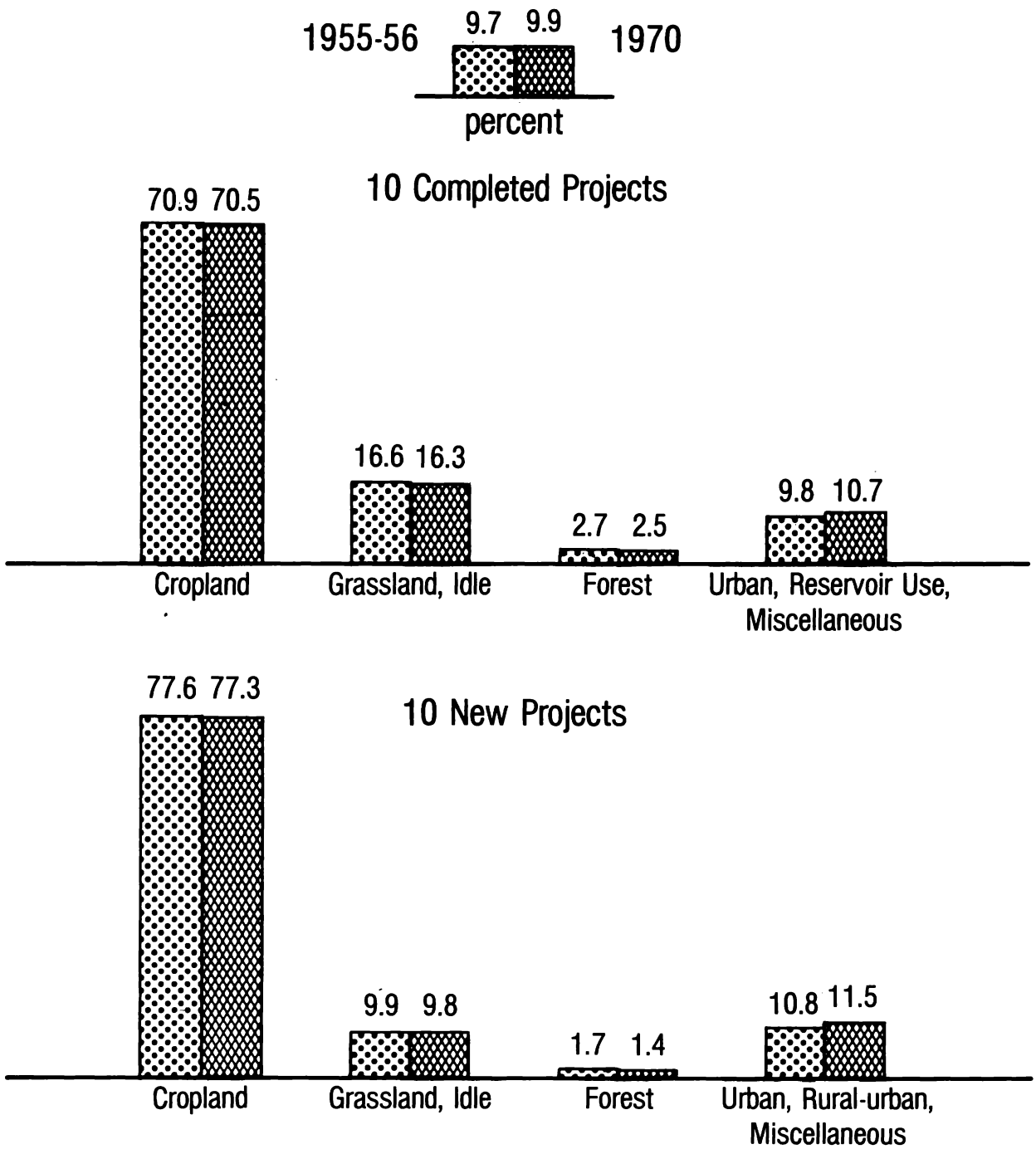
Table 3--Expected benefits for completed and incomplete projects, Missouri River tributaries region

Benefits	Completed projects		Incomplete projects	
	Sample of 10	Total in LRA's (32) 1/	Sample of 10 (new)	Total in LRA's (63) 1/
	Percent of total benefits			
Total damage reduction	87.60	73.43	61.92	80.25
Land enhancement:				
Restoration of productivity 2/	0	0	0	0
More intensive land use	1.59	2.70	7.02	2.45
Changed land use, agricultural	8.14	5.23	2.26	3.35
Changed land use, urban	0	0	0	0
Total land enhancement	9.73	9.73	9.28	5.80
Drainage	0	0	0	0
Irrigation	0	0	0	0
Benefits from all other purposes	2.67	16.84	28.80	13.95
Total	100.00	100.00	100.00	100.00

1/ Land Resource Areas 102, 106, 107, 109. Numbers in parentheses refer to numbers of projects covered.
2/ Included in flood damage reduction.

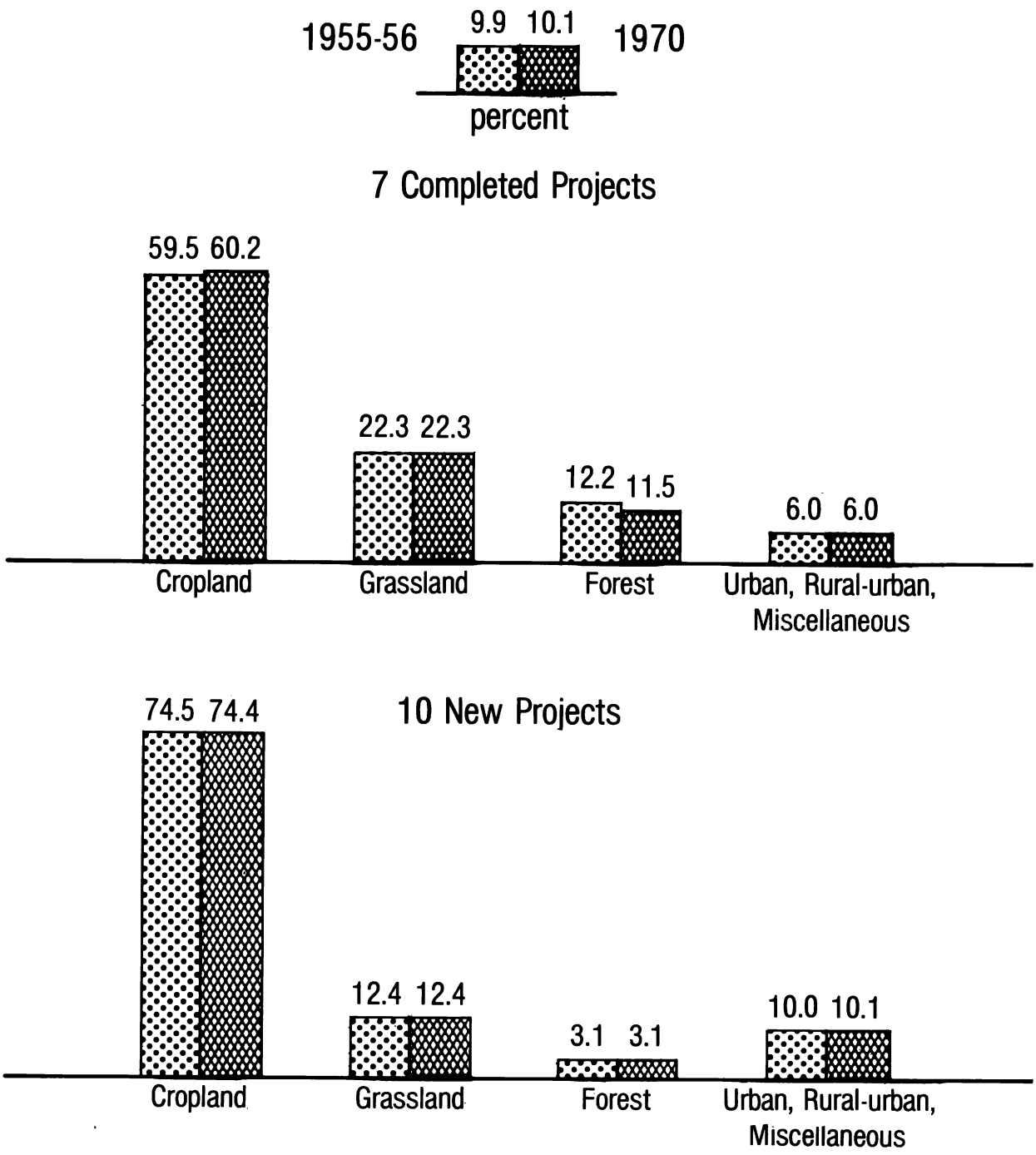
Source: Watershed work plans published by Soil Conservation Service, USDA.

Figure 6. Land Uses on Missouri River Tributaries Upland Areas, 1955-56 and 1970*



* Change interval for completed projects averaged 14.7 years (1955-70); for new projects it averaged 13.8 years (1956-70).

Figure 7. Land Uses on Missouri River Tributaries Bottomland Areas*, 1955-56 and 1970**



* Bottomlands are those areas expected to benefit from flood damage reduction and/or drainage.

** Change interval for completed projects averaged 14.7 years (1955-70); for new projects it averaged 13.8 years (1956-70).

contour tillage, terracing, and grass waterways. On some completed projects, nearly all of the upland showed evidence of these practices by 1970. 10/ The expected recovery of land from reshaped gullies was also not identifiable on the photos used. Gullies are difficult to locate without steroscopic examination of contact photographs--a time-consuming and expensive process. If planned measures have been carried out on completed projects, some added cropland or grassland was no doubt in use by 1970.

10/ Resolution on recent photos was generally much better than on early photos. An unsuccessful attempt was made on several areas to quantify the installation of these practices over the photo interval.

CONCLUSIONS

Southeast

The land use changes revealed by this study are consistent with regional trends identified during the post-World War II period. Frey and other (3) report a 40 percent drop in cropland for the Southeast from 1954 to 1966. Both samples in this study show declines in cropland and grassland acreages over the 15 years, 1954-69. However these changes were less dramatic than reported by Frey. Apparently, the project areas experienced a slower decline in farming intensity than was typical for the region.

However, the combination of relatively small farms (119-139 acres) and the small fractions in crops and grassland indicates a very small scale of production. Undoubtedly, most farmers have been forced to supplement their incomes with off-farm work. For example, the 12 South Carolina counties having sample watersheds reflected an increase in off-farm work from 54 percent of the farmers reporting in 1954 to 65.6 percent in 1969 (1). This indicates that farming is a part-time activity for many farmers, with little incentive or available capital to expand operations by taking advantage of reduced flood hazards. Furthermore, fields tend to be small, with flood plain areas often only a few hundred feet wide and bounded by meandering streams. Reclamation of these small, previously abandoned strips, now given partial flood protection, probably involves more labor and capital for clearing and fence renewal than can be justified by expected increased crop returns.

In summary, although the Southeast region has exhibited a strong trend away from intensive crop farming, the trend on the sample watersheds was much weaker. Area in crops and grassland decreased only about 15 percent over the 15-year period. On the other hand, completed projects have not shown the expected response in reclamation of idle land into crops or permanent pastures.

Lack of expansion in crop production is probably due to the decreasing dependence on farming as the major source of income. However, protection from flooding may have enabled farmers to maintain present flood plain fields that might otherwise have shifted to idle land or grassland. Trends on uplands from crop production to forests were more pronounced on completed projects than on new ones. Land treatment programs on watershed projects, encouraging the establishment of permanent cover on these lands, probably accounts for this response. The offsetting production increases from protected flood plain fields may have made these shifts possible.

The consistently high percent of idle-transition land on the undeveloped project areas is probably related to the reported shift from crop to livestock farming (noted in work plans). These lands are frequently used as unmanaged pasture. Since cropland area on protected bottomland has been stable for 15 years, it is reasonable to expect more intensive management for feed grains, hay, or improved pastures to support expanding beef production, as the work plans project.

Interpretations of the data are tenative since we do not know what ownership changes have occurred over the 15-year interval. County census data indicate drastic declines in farm numbers and crop acreage. The extent to which these changes have influenced the observed land use changes on project areas is not known.

Mississippi Delta

While topographic features, water problems, and land uses are consistently alike for the samples of new and completed projects in the Delta, there are sufficient differences between northern (Arkansas-Mississippi) and southern (Louisiana) projects to require separate analysis. The overall picture of land uses changes is one of expanding agriculture on bottomlands, both benefited and nonbenefited, and static or declining intensity of use on uplands.

Watershed projects in the Arkansas-Mississippi portion of the Delta region were initiated earlier than in the flatlands of Louisiana. Conversion of this northern portion from forest to cropland was well advanced by 1950 (2). On projects sampled, crops and grassland occupied 55 percent of completed and 66 percent of the new benefited bottomlands in 1957. Further clearing was much more rapid on the eight completed watersheds than on the new ones in Arkansas-Mississippi. We conclude that the combination of watershed development with improved major flood control and drainage works (Corps of Engineers projects) made possible the agricultural use of nearly 80 percent of these benefited lands, an increase of 23 percentage points. In contrast, during these 13 years the areas to be benefited in the five new projects in the north showed less than 7 percentage points increase in agricultural use, from about 66 to 73 percent.

Similar comparisons of benefited areas of completed projects in Louisiana were not possible. The five new projects in Louisiana showed a rate of conversion--forest to cropland--almost identical to the completed Arkansas projects, cropland gaining 23 percentage points over the interval. The major difference was the much lower level of initial agricultural use of the Louisiana areas in 1957 --38 percent of the benefited area. In 1970, over 30 percent forest land remained, much of which could be converted to cropland, given flood protection and drainage. The uncertainty of this future development stems from the sizable timber company ownerships and their decisions on converting from wood production to crops, or selling land to agricultural developers.

Conclusions about land use changes on nonbenefited areas are difficult to generalize because of the varying proportions of rolling or hilly upland and flat bottomland. The completed Arkansas projects (seven containing nonbenefited area) had extensively developed, mostly bottomland areas. On these there was a consistent, modest increase in cropland from forest clearing. The one Louisiana project also showed a large forest to cropland conversion of rolling upland, probably to improved hay and pasture. Two of the three new Arkansas projects had hilly uplands, which exhibited most of the cropland losses. On one area, about 12,000 acres changed from crops to pasture, accounting for most of the shift. The nonbenefited areas on the three Louisiana projects were all flatland. Two showed sizable gains in cropland; one lost a similar amount of cropland to urban development. All six projects showed losses of forest land, though mostly in minor amounts.

In summary, we conclude that cropland is steadily expanding on those lands suited by terrain to intensive cultivation. In some cases, this expansion has been accompanied by conversion of cropland to permanent cover where terrain contributed to erosion problems. The combination of the major flood control and drainage works, principally by the Corps of Engineers, with complementary development of small watershed projects, will probably continue to make possible the rapid expansion of intensive cropping, displacing lower intensity forest uses.

Missouri River Tributaries

Stability in land use patterns was expected in this region, and was confirmed by this study. With little land remaining to be cleared, only small amounts of cropland could be added. If rotations have been modified to include more years in grass or hay, as expected by planners, this was not distinguished on summer photographs from corn or other annual crops. Although late photos showed changes in the style of tillage (contour, strip, etc.) and terracing plus addition of grass waterways for both samples, the amount of these changes could not be measured. The installation of soil conserving practices has apparently been progressing for some time. It was no doubt hastened with the installation of project measures for erosion and flood control.

The predicted conversions of bottomland forest to crops on completed projects were not realized. It was learned (after photo interpretation was completed) that one project has not installed any of the five flood control dams planned; consequently, there was no incentive to intensify use of the 500 acres of wooded flood plain.

IMPLICATIONS FOR EVALUATING LAND ENHANCEMENT BENEFITS

Planners of Southeast projects were optimistic regarding the expansion of bottomland cropping. The projected expansion of cropland on Mississippi Delta benefited lands was probably conservative. The almost unchanging pattern of land uses in the Missouri tributaries region was mostly anticipated by planners. We are concerned here with the reasons why projections of changes in land use missed the mark in the two regions--the Southeast and the Mississippi Delta.

Inputs of capital, labor, or both are required for the achievement of land enhancement benefits (restoration of productivity, change in land use, and intensified use). Chapter Four of the Economics Guide for Watershed Protection and Flood Prevention details the procedures for evaluating these benefits (6, Ch. 4, p. 1). This study was able to identify most or all of the first two kinds of change on both completed projects and on new project areas over the approximate period 1955-70.

Among the factors which could have helped shape work plan projections are the following:

1. Organization of farm enterprises and the potential availability of capital resources.

2. Trends in farm size and cropland proportions.

3. Trends in available off-farm work.

4. Suitability of land and of possible field size to mechanized farming.

Had these factors been explicitly considered, they might have influenced the projections in a number of ways.

Southeast--In this region, these four factors reinforced one another to indicate a trend away from intensive crop production. At the time early projects were planned, most farms were below the commercial minimum of $2,500 of annual farm sales. Depressed farm incomes and a small cropland base were characteristic of farms in the area. Off-farm work was prevalent. It follows that capital availability for most of these owners was poor to nonexistent. There was little likelihood of investments to enlarge crop areas by clearing and fencing. Thus the optimistic reports by these farmers regarding plans to reestablish old flood plain fields or clear new ones should have been heavily discounted. In addition, the narrow flood plains and small, irregular available parcels militated against creation of efficient-sized fields for machine cultivation. This would be especially important for owners who farmed only part time while holding full-time, off-farm jobs.

Mississippi Delta--The above four factors combined to present a quite different picture in the Delta region. Commercial farms of reasonable size were develop-

ing rapidly during the early 1950's in the flat bottomlands of southeastern Missouri and eastern Arkansas, although hill farms remained small and marginal. Farm mechanization was progressing. Consolidation of ownership indicated capital availability and an aggressive, crop-based agriculture. Land clearing was common and appeared to be linked to better control of water regimes and flooding. In these circumstances it would seem inevitable that improved drainage, linked to the arterial channel system being installed by the Corps of Engineers and other projects, would hasten the coversion of remaining hardwood forests to highly productive, generally large, crop fields. The benefits of these watershed projects may have been underestimated. Planners were restricted from projecting these conversions by USDA policy against bringing new land into crop production (6, Ch. 4, p. 1).

The above discussion of the four listed factors is not meant to infer that still other factors may not be important in affecting the changes following project installation. The trend toward meat production (beef and poultry, especially) in the Southeast was underway during early project planning, though perhaps it was not clearly the dominant future agricultural pattern. In the Delta, corn and cotton were still major crops in 1957, and both were in excess supply. This explains in part the conservative estimates for cropland expansion resulting from project installation. The phenomenal growth in demand (and price) for soybeans was not then anticipated. Planners of later projects were less inhibited in forecasting these changes. However, in future predictions of major shifts to crop production, at least in Louisiana, the intentions and capabilities of timber owners for maintaining wood production on their lands should be fully investigated.

RECOMMENDATIONS

In predicting the use of benefited lands, planners now depend on three major kinds of information:

1. Land use capability and soil productivity.

2. Farmers' intentions.

3. Relative productivity of land in different uses.

Additional factors which should be carefully considered are:

1. Available capital and labor, or both, to achieve land use conversions.

2. Trends in farm size and organization, such as full-time commercial, part or spare time, or tenant.

3. Growth in off-farm labor opportunities and availability of hired farm labor.

4. Long-term demands for those crops which are suited to local soils, climate, and the developing patterns of farm size and organization.

5. Institutional controls which may be applied to keep land use compatible with levels of flood protection (e.g., P.L. 93-234, Flood Disaster Protection Act of 1973).

When consideration of these factors (and any others deemed locally important) indicates a pattern of land use inconsistent with preliminary projections, based on the first three factors listed above, it may be necessary to seek out analogous situations elsewhere for study and guidance. Previously established trends in the region, when analyzed, may reveal other unsuspected factors important in anticipating the actual changes in land use following flood protection and improved water management.

In summary, the job of planners is to determine whether the provision of improved water management will supply the critical factor needed to effect improved or intensified use of the lands benefited. Where other factors do not favor these changes, the hoped-for benefits may not be realized.

This study has revealed land use patterns devergent from those expected by early planners in two regions. However, details of these changes were not revealed by photo analysis. Two kinds of change, not determinable by photo analysis but related to the changes reported, are ownership shifts and changes in cropping and management intensity on remaining croplands. Securing this information would require detailed study of selected projects, and could be combined with the collection of other valuable ex post information on completed project areas. Such a study of Southeast and Mississippi Delta projects should clarify and evaluate the effects of project development in relation to other factors affecting land use.

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APPENDIX

Appendix tables 1, 2, and 3 provide supporting data on the individual watersheds. Photo dates are given for each project. In appendix tables 4-15, the original acreage refers to the date of early photography. Change columns report the change over the interval concluded by the date of late photography. It should be noted that reservoir acres are reported only for upland or nonbenefited areas. In appendix tables 16-23, land uses and land use changes are documented, supporting figures 2-7 in the text.

Appendix table 1--Small watershed projects sampled for land use changes, Southeast region

Category and number	Project name	Dates of photos	Area	Benefited area
Completed projects:			Acres	Percent
2	Bear Creek, Ga.	1956-72	23,324	6.7
24	Rocky Creek, Ga.	1955-67	20,700	3.3
26	Coneross Creek, S.C.	1954-70	43,300	7.1
45	Rooty Creek, Ga.	1956-71	29,483	6.0
82	Mountain Run, Va.	1950-66	28,700	4.8
143	Brushy Creek, S.C.	1956-70	23,512	2.8
161	Wateree Creek, S.C.	1955-70	35,000	4.3
245	Huff Creek, S.C.	1956-70	21,787	2.6
277	Sandy Creek, Ga.	1955-67	21,000	5.0
369	Hills Creek, S.C.	1957-69	14,067	3.8
Average			26,087	4.9
New projects:				
912	Beaverdam Creek, S.C.	1954-70	24,269	4.1
913	Brown's Creek, S.C.	1951-70	27,256	3.7
914	Cane Creek, S.C./N.C.	1951-70	94,721	3.2
915	Jackson-Miller Creek, S.C.	1952-70	38,170	3.8
978	Soque Creek, Ga.	1956-67	84,055	3.0
990	N. Tyger Run, S.C.	1955-71	21,700	1.9
997	Beaverdam-Warrior Creek, S.C.	1954-70	35,600	4.1
1,013	N. Oconee Run, Ga.	1956-67	57,345	8.1
1,018	Rocky Creek, S.C.	1954-69	126,300	3.9
1,019	Wilson Creek, S.C.	1959-70	49,900	5.0
Average			59,932	4.1

Appendix table 2--Small watershed projects sampled for land use change, Mississippi Delta region

Category and number	Project name	Dates of photos	Area	Benefited area
			Acres	Percent
Completed projects:				
51	Caney Creek, Ark.	1954-67	39,680	46.4
84	Camp Bayou, Ark.	1955-68	21,756	42.0
164	Baker Canal, La.	1957-71	21,600	100.0
174	Randolph-Walnut Lake, Ark.	1958-71	13,564	66.1
285	Fourche Bayou, Ark.	1955-66	14,322	8.9
290	Arkansas City, Ark.	1958-71	16,143	100.0
310	Bayou Rapides, La.	1957-68	96,970	10.9
370	Chicot, Desha, Drew, Ark.	1958-71	41,227	90.5
426	Crooked Bayou, Ark.	1958-71	31,499	98.4
546	Canal 18, Ark.	1958-71	38,850	90.1
Average			33,561	56.4
New projects:				
849	Larkin Creek, Ark.	1954-70	35,758	100.0
879	Central Madison, La.	1956-69	97,200	100.0
880	Upper Bayou Teche, La.	1957-68	210,000	49.5
893	Tri-county Hopson Bayou, Miss.	1957-66	28,970	100.0
939	Poinsett, Ark.	1954-67	51,326	31.0
943	Chatlin Lake Canal, La.	1957-68	99,500	68.3
944	Walnut-Roundaway, La.	1956-69	227,700	98.0
949	Des Arc Bayou, Ark.	1955-66	65,485	9.8
979	North Concordia, La.	1953-69	225,000	100.0
998	Fish Bayou, Ark.	1954-68	36,242	73.3
Average			106,951	77.0

Appendix table 3--Small watershed projects sampled for land use changes, Missouri River tributaries region

Category and number	Project name	Dates of photos	Area	Benefited area
Completed projects:			Acres	Percent
8	Harmony Creek, Iowa	1954-72	33,100	0
62	Rocky Branch, Iowa	1957-69	8,663	0
63	Simpson Creek, Iowa	1955-71	2,393	9.4
83	Thompsonville, Kans.	1954-66	4,062	7.1
140	Platte River Tributaries, Mo.	1957-69	12,800	6.3
149	Walnut Creek, Kans./Nebr.	1954-72	80,594	12.5
234	White Clay, et. al. Creek's, Kans.	1954-72	12,540	1.7
247	Tabo Creek, Mo.	1957-69	84,895	3.6
287	Hamburg, Iowa	1955-71	2,365	.3
363	Nebo Creek, Kans.	1956-69	9,360	7.5
Average			22,077	7.0
New projects:				
895	Little Sni-a-bar, Mo.	1957-69	24,896	4.7
917	Hurley Creek, S.Dak.	1956-70	27,000	13.9
937	Mud Creek, S.Dak.	1958-71	16,580	6.0
963	Ledgewood Creek, Iowa	1955-71	7,500	10.7
984	Aowa Creek, Nebr.	1955-71	55,350	3.9
996	Pioneer, Iowa	1956-68	5,280	1.5
1,002	Simon Run, Iowa	1955-66	4,150	14.0
1,049	Clear Creek, Nebr.	1955-71	54,820	3.8
1,066	Union Creek, S.Dak.	1956-68	30,300	3.9
1,068	Tekamah-Mud, Nebr.	1955-71	19,080	5.0
Average			24,496	5.6

Appendix table 4--Net land use changes on nonbenefited areas of completed projects, by project number, Southeast region 1/

Item	Total nonbenefited area	Cropland		Grassland		Idle-transition		Forest		Urban		Rural-urban		Miscellaneous		Reservoirs	
		Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.
Project number:							Acres										
2	21,768	4,593	-2,351	7,096	0	5,747	0	2,699	+2,286	87	+65	283	0	1,263	0	0	0
24	20,008	1,140	-500	5,982	-80	0	0	10,646	+360	1,140	+220	360	0	740	0	0	0
26	40,213	11,708	-3,377	601	0	6,528	-120	16,210	+2,056	2,603	+1,281	1,081	0	1,482	0	0	+160
45	27,712	3,070	-941	6,828	-191	7,262	-16	8,782	+787	553	+305	277	0	940	0	0	+56
82	27,332	6,480	-134	10,636	-618	2,603	0	3,678	-152	1,811	+651	905	0	1,219	0	0	+253
143	22,857	8,063	-2,369	1,893	-2	2,027	0	6,341	+1,449	829	+843	781	0	2,923	0	0	+79
161	33,504	1,106	-584	4,120	+278	0	0	26,435	+223	0	0	265	0	1,578	0	0	+73
245	21,217	6,071	-1,895	4,476	-25	950	0	5,058	+1,670	1,181	+127	623	0	2,858	0	0	+123
277	19,957	5,856	-1,863	1,712	-4	1,311	0	8,874	+1,571	143	+199	446	0	1,615	0	0	+97
369	13,527	2,935	-270	1,758	0	81	0	7,721	+192	458	+27	230	0	344	0	0	+51
Total	248,095	51,022		45,102		26,509		96,444		8,805		5,251		14,962		0	
Net change			-14,284		-642		-136		+10,452		+3,718		0		0		+892
							Percent										
Original	100.00	20.56		18.17		10.70		38.90		3.55		2.11		6.02		0	
Recent	100.00	14.80		17.92		10.64		43.11		5.05		2.11		6.02		.36	

1/ See appendix table 15.

Appendix table 5--Net land use changes on benefited areas of completed projects, by project number, Southeast region 1/

Item	Total benefited area	Cropland		Grassland		Idle-transition		Forest		Urban		Rural-urban		Miscellaneous	
		Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.
							Acres								
Project number:															
2	1,556	143	0	160	0	1,110	0	19	0	0	0	0	0	48	0
24	692	44	-22	296	0	0	0	352	+22	0	0	0	0	0	0
26	3,087	1,043	0	43	0	145	0	1,689	0	0	0	0	0	167	0
45	1,771	248	-106	425	0	903	0	71	106	0	0	0	0	124	0
82	1,368	190	0	792	0	41	0	183	0	114	0	0	0	48	0
143	655	101	0	47	0	41	0	434	0	0	0	0	0	32	0
161	1,496	34	-19	498	0	0	0	886	+19	0	0	0	0	78	0
245	570	14	0	58	0	0	0	492	0	0	0	0	0	6	0
277	1,043	337	+11	131	0	97	0	466	-11	0	0	0	0	12	0
369	540	75	0	130	0	0	0	355	0	0	0	0	0	0	0
Total	12,778	2,229		2,580		2,337		4,927		114		0		591	
Net change			-136		0		0		+136		0		0		0
							Percent								
Original	100.00	17.44		20.19		18.29		38.56		.86		0		4.63	
Recent	100.00	16.38		20.19		18.29		39.62		.86		0		4.63	

1/ See appendix table 15.

Appendix table 6--Net land use changes on nonbenefited areas of new projects, by project number, Southeast region 1/

Item	Total nonbenefited area	Cropland		Grassland		Idle-transition		Forest		Urban		Rural-urban		Miscellaneous		Reservoirs	
		Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.
								Acres									
Project number:																	
912	23,277	8,473	-326	4,586	0	1,769	0	6,401	+194	0	0	304	0	1,744	0	0	+132
913	26,167	3,140	-445	3,716	-26	1,021	-131	15,045	-23	1,207	+367	302	0	1,736	0	0	+258
914	91,674	11,458	-4,601	26,585	-657	28,419	-565	14,028	+3,138	4,767	+2,016	2,567	0	3,850	0	0	+669
915	36,738	2,829	-1,626	4,114	-220	698	-110	24,688	+1,059	1,029	+477	288	0	3,092	0	0	+420
978	81,538	2,397	170	408	0	72,872	-104	4,394	-368	326	+164	489	0	652	0	0	+138
990	21,280	8,808	-2,471	1,256	-43	4,788	-159	3,383	+1,689	468	+726	1,298	0	1,279	0	0	+258
997	34,147	11,611	-1,707	3,005	0	9,902	-34	7,171	+1,525	102	+34	546	0	1,810	0	0	+182
1,013	52,713	8,065	-880	5,904	0	9,541	-7	24,196	+616	369	+105	843	0	3,795	0	0	+166
1,018	121,332	18,927	-4,774	12,376	-121	41,617	-164	40,768	+3,819	2,305	+727	1,820	0	3,519	0	0	+513
1,019	47,424	7,540	-1,612	4,648	-332	14,038	-711	11,571	-624	5,881	+2,987	1,138	0	2,608	0	0	+292
Total	536,290	83,248		66,598		184,631		151,645		16,454		9,595		24,085		0	
Net change			-18,272		-1,399		-1,985		+11,025		+7,603		0		0		+3,028
								Percent									
Original	100.00	15.52		12.42		34.43		28.28		3.07		1.79		4.49			0
Recent	100.00	12.12		12.16		34.06		30.33		4.49		1.79		4.49			56

1/ See appendix table 15.

Appendix table 7--Net land use changes on benefited areas of new projects, by project number, Southeast region 1/

Item	Total benefited area	Cropland		Grassland		Idle-transition		Forest		Urban		Rural-urban		Miscellaneous	
		Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.
							Acres								
Project number:															
912	992	190	-15	29	0	102	0	656	+15	0	0	0	0	15	0
913	1,089	73	-14	14	0	0	0	988	+14	0	0	0	0	14	0
914	3,047	131	-82	555	0	1,806	0	195	+82	0	0	0	0	360	0
915	1,432	321	0	0	0	59	0	0	0	0	0	0	0	1,052	0
978	2,517	1,885	+13	63	0	493	0	51	-13	0	0	0	0	25	0
990	420	0	0	0	0	383	0	0	0	0	0	0	0	37	0
997	1,453	291	0	0	0	809	0	248	0	0	0	0	0	105	0
1,013	4,632	1,931	-32	352	0	1,251	0	871	+32	0	0	0	0	227	0
1,018	4,968	283	-20	85	0	3,770	-	298	+20	0	0	20	0	512	0
1,019	2,476	327	0	0	0	1,530	0	327	0	0	0	0	0	292	0
Total	23,026	5,432		1,098		10,203		3,634		0		20		2,639	
Net change			-150		0		0		+150		0		0		0
							Percent								
Original	100.00	23.59		4.77		44.31		15.78		0		.09		11.46	
Recent	100.00	22.94		4.77		44.31		16.43		0		.09		11.46	

1/ See appendix table 15.

Appendix table 8--Net land use changes on nonbenefited areas of completed projects, by project number, Mississippi Delta region 1/

Item	Total nonbenefited area	Cropland		Grassland		Idle-transition		Forest		Urban		Rural-urban		Miscellaneous		Reservoirs	
		Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.
								Acres									
Project number:																	
51	21,252	11,009	603	3,875	-60	589	-191	3,766	-1,062	755	419	252	0	1,006	0	00	291
84	12,612	10,366	88	328	0	0	0	265	-88	114	0	429	0	1,110	0	0	0
164	0																0
174	4,604	3,365	-28	502	-28	134	0	78	0	101	56	212	0	212	0	0	0
285	3,047	7,217	26	1,657	0	300	0	1,095	-130	1,174	104	378	0	1,226	0	0	0
290	0																
310	86,446	5,351	2,762	11,221	-173	86	0	61,934	-3,674	2,503	950	1,208	0	4,143	0	0	135
370	3,896	2,513	530	249	0	0	0	530	-530	495	0	70	0	39	0	0	0
426	510	244	0	0	0	0	0	177	0	0	0	89	0	0	0	0	0
546	3,850	2,055	89	308	0	31	0	1,028	-89	108	0	89	0	231	0	0	0
Total	146,217	42,120		18,140		1,140		68,873		5,250		2,727		7,967		0	
Net change			4,070		-261		-191		-5,573		1,529		0		0		426
								Percent									
Original	100.0	28.81		12.41		.78		47.10		3.59		1.86		5.45		0	
Recent	100.0	31.59		12.23		.65		43.29		4.64		1.86		5.45		.29	

1/ See appendix table 15.

Appendix table 9--Net land use changes on benefited areas of completed projects, by project number, Mississippi Delta region 1/

Item	Total benefited ares	Cropland		Grassland		Idle-transition		Forest		Urban		Rural-urban		Miscellaneous	
		Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.
Project number:							Acres								
51	18,428	10,891	2,396	1,087	0	313	-37	3,999	-2,414	240	+55	461	0	1,437	0
84	9,144	4,673	1,097	338	0	73	0	3,155	-1,097	128	0	238	0	539	0
164	21,600	13,932	497	0	0	0	0	6,372	-540	432	+43	432	0	432	0
174	8,960	6,056	0	995	-36	63	0	162	-81	663	+117	179	0	842	0
285	1,275	693	46	108	0	0	0	400	-46	0	0	8	0	66	0
290	16,143	9,380	2,744	1,001	0	194	0	3,712	-2,760	565	+16	129	0	1,162	0
310	10,524	6,009	53	1,821	0	0	0	327	-53	21	0	1,136	0	1,210	0
370	37,331	22,549	6,458	933	0	0	0	10,340	-6,458	1,120	0	560	0	1,829	0
426	30,989	5,640	18,625												
546	35,000	19,130													
426	30,989	5,640	18,625	279	0	62	0	23,087	-18,625	0	0	93	0	1,828	0
546	35,000	18,130	5,390	3,955	0	735	0	7,945	-5,390	1,225	0	420	0	2,590	0
Total	189,394	97,953		10,517		1,440		59,499		4,394		3,656		11,935	
Net change			37,306		-36		-37		-37,464		+231		0		0
							Percent								
Original	100.00	51.72		5.55		.76		31.42		2.32		1.93		6.30	
Recent	100.00	71.42		5.53		.74		11.63		2.44		1.93		6.30	

1/ See appendix table 15.

Appendix table 10--Net land use changes on nonbenefited areas of new projects, by project number, Mississippi Delta region 1/

Item	Total nonbenefited area	Cropland		Grassland		Idle-transition		Forest		Urban		Rural-urban		Miscellaneous		Reservoirs	
		Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.
								Acres									
Project number:																	
849	0																
879	0																
880	106,000	29,998	+2,014	2,756	0	0	0	57,876	-2,014	3,498	0	3,922	0	7,950	0	0	0
893	0																
939	35,425	11,797	-531	8,042	-1,311	0	0	11,761	-815	106	+638	1,204	0	2,515	+117	0	+1,842
943	31,500	4,536	-1,197	662	0	0	0	2,552	-725	22,710	+1,922	315	0	725	0	0	0
944	4,518	0	+1,242	0	0	0	0	4,482	-1,242	0	0	0	0	36	0	0	0
949	59,055	20,595	-11,501	14,779	+12,091	118	0	21,555	-649	0	+59	886	0	1,122	0	0	0
979	0																
998	9,675	6,318	-78	0	0	0	0	1,799	-19	116	+97	329	0	1,113	0	0	0
Total	246,173	73,224		26,239		118	0	100,025		26,430		6,656	0	13,461		0	
Net change			-10,051		+10,780				-5,464		+2,716		0		+117		+1,842
								Percent									
Original	100.00	29.75		10.66		.05		40.63		10.74		2.70		5.47		0	
Recent	100.00	25.67		15.04		.05		38.41		11.84		2.70		5.54		.75	

1/ See appendix table 15.

Appendix table 11--Net land use changes on benefited bottomland areas of new projects, by project number, Mississippi Delta region 1/

Item	Total benefited area	Cropland		Grassland		Idle-transition		Forest		Urban		Rural-urban		Miscellaneous	
		Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.
							Acres								
Project number:															
849	35,758	20,024	4,184	2,360	0	0	0	9,905	-4,184	0	0	1,252	0	2,217	0
879	89,530	12,803	18,801	985	0	90	0	72,698	-18,801	0	0	895	0	2,059	0
880	104,000	69,368	1,664	2,912	0	0	0	17,368	-1,768	1,664	+104	4,888	0	7,800	0
893	28,970	16,861	406	2,868	0	579	0	4,172	-406	579	0	1,072	0	2,839	0
939	15,901	12,450	875	302	0	0	0	1,384	-875	0	0	302	0	1,463	0
943	68,000	26,248	12,784	5,440	0	136	0	29,512	-12,784	884	0	1,768	0	4,012	0
944	223,182	82,130	60,483	8,558	-300	298	0	115,458	-61,002	1,785	+819	3,794	0	11,159	0
949	6,430	2,076	405	977	0	148	0	2,888	-405	0	0	19	0	322	0
979	225,000	46,355	70,645	12,148	-224	1,799	0	146,698	-73,124	4,050	+2,703	3,375	0	10,575	0
998															
Total	823,338	305,903		36,550		3,050		404,121		8,989		18,321		46,404	
Net change			171,946		-524		0		-175,075		+3,653		0		0
							Percent								
Original	100.00	37.15		4.44		.37		49.08		1.09		2.23		5.64	
Recent	100.00	58.04		4.37		.37		27.82		1.53		2.23		5.64	

1/ See appendix table 15.

Appendix table 12--Net land use changes on upland areas of completed projects, by project number, Missouri Rivers tributaries region 1/

Item	Total upland area	Cropland		Grassland		Idle-transition		Forest		Urban		Rural-urban		Miscellaneous		Reservoirs	
		Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.
								Acres									
Project number:																	
8	3,100	2,777	-30	225	-14	0	0	0	0	0	0	92	0	6	0	0	+44
62	8,663	4,990	+121	2,833	0	121	0	355	-121	0	0	173	0	191	0	0	0
63	2,168	1,793	-4	150	0	0	0	74	-16	0	0	82	0	69	0	0	+20
83	3,774	2,577	-42	726	-3	101	0	198	-15	15	+30	101	0	56	0	0	+30
140	12,000	6,944	+44	3,353	-27	0	0	398	-51	156	0	407	0	742	0	0	+34
149	70,549	57,434	-82	7,346	-256	0	0	488	-207	491	0	1,966	0	2,824	+195	0	+350
234	12,322	4,792	-283	3,237	-219	12	0	609	-27	2,060	+327	630	0	982	0	0	+202
247	81,829	57,934	-409	12,847	0	0	0	2,946	0	1,392	+409	3,273	0	3,437	0	0	0
287	2,357	1,516	-21	204	0	0	0	97	-15	297	+21	112	0	131	0	0	+15
363	8,660	4,833	-23	2,762	-9	86	0	481	-52	0	0	189	0	309	0	0	+84
Total	205,422	145,590		33,683		320		5,646		4,411		7,025		8,747		0	
Net change			-729		-528		0		-504		+787		0		+195		+779
								Percent									
Original	100.00	70.87		16.40		.16		2.75		2.15		3.42		4.26		0	
Recent	100.00	70.52		16.14		.16		2.50		2.53		3.42		4.26		.38	

1/ See appendix table 15.

Appendix table 13--Net land use changes on benefited bottomland areas of completed projects, by project number, Missouri River tributaries region 1/

Item	Total bottom-land area	Cropland		Grassland		Idle-transition		Forest		Urban		Rural-urban		Miscellaneous	
		Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.
Project number:							Acres								
8	0		0												
62	0														
63	225	185	0	0	0	0	0	0	0	0	0	0	0	40	0
83	288	288	0	0	0	0	0	0	0	0	0	0	0	0	0
140	800	626	0	94	0	0	0	54	0	0	0	0	0	26	0
149	10,045	5,475	110	2,813	0	0	0	1,175	-110	0	0	70	0	512	0
234	218	34	0	50	0	0	0	0	0	126	0	0	0	8	0
247	3,066	1,993	0	469	0	0	0	500	0	0	0	49	0	55	0
287	8	0	0	0	0	0	0	0	0	8	0	0	0	0	0
363	700	528	0			0	0	147	0	0	0	0	0	25	0
Total	15,350	9,129		3,426				1,876		134		119		666	
Net change			110		0				-110		0		0		0
							Percent								
Original	100.00	59.47		22.32				12.22		.87		.77		4.34	
Recent	100.00	60.19		22.32				11.50		.87		.77		4.34	

1/ See appendix table 15.

Appendix table 14--Net land use changes on upland areas of new projects, by project number, Missouri River tributaries region 1/

Item	Total upland area	Cropland		Grassland		Idle-transition		Forest		Urban		Rural-urban		Miscellaneous		Reservoirs	
		Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.
								Acres									
Project number:																	
895	23,718	13,140	-57	6,380	-190	47	0	2,135	-243	0	+332	806	0	1,210	0	0	+158
917	23,240	20,195	-51	1,371	0		0		0	349	0	790	0	535	0	0	+51
937	15,581	11,904	0	2,772	-12		0	16	0	31	0	405	0	452	0	0	+12
963	6,700	5,728	-12	422	-10		0	208	-12		0	248	0	94	0	0	+34
984	53,190	42,445	-170	6,276	-56		0	266	-49	426	0	1,862	0	1,915	0	0	+275
996	5,200	4,227	0	652	0		0	111	0		0	98	0	112	0	0	0
1,002	3,570	2,214	0	599	0		0	378	0		0	239	0	140	0	0	0
1,049	52,730	40,578	-208	1,822	0		0	36	0	4,995	0	2,121	0	3,178	0	0	+208
1,066	29,130	25,344	-93	1,165	0		0	174	0		0	1,282	0	1,165	0	0	+93
1,068	18,125	13,630	-87	1,468	-13	54	0	472	-157	163	+54	1,015	0	1,323	0	0	+203
Total	231,184	179,405		22,928		101		3,796		5,964		8,866		10,124		0	
Net change			-678		-281		0		-461		+386		0		0		+1,034
								Percent									
Original	100.00	77.60		9.92		.04		1.64		2.58		3.84		4.38		0	
Recent	100.00	77.31		9.80		.04		1.44		2.74		3.84		4.38		.45	

1/ See appendix table 15.

Appendix table 15--Net land use changes on benefited bottomland areas of new projects, by project number, Missouri River tributaries region 1/

Item	Total bottom-land area	Cropland		Grassland		Idle-transition		Forest		Urban		Rural-urban		Miscellaneous	
		Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.	Orig.	Chng.
							Acres								
Project number:															
895	1,178	581	0	269	0	0	0	223	0	0	0	0	0	105	0
917	3,760	3,601	0	53	0	0	0	0	0	0	0	53	0	53	0
937	999	360	0	492	0	0	0	27	0	40	0	40	0	40	0
963	800	746	0	0	0	0	0	0	0	0	0	11	0	43	0
984	2,160	1,789	0	162	0	0	0	45	0	15	0	15	0	134	0
996	80	40	0	40	0	0	0		0	0	0	0	0		
1,002	580	208	0	252	0	0	0	101	0	0	0	0	0	19	0
1,049	2,090	1,399	0	236	0	0	0		0	0	0	192	0	263	0
1,066	1,170	940	0	157	0	0	0	5	0	0	0	26	0	42	0
1,068	955	592	-11	55	-11	0	0	22	0	187	+22	11	0	88	0
Total	13,772	10,256		1,716				423		242		348		787	
Net change			-11		-11				0		+22		0		0
							Percent								
Original	100.00	74.47		12.46		0		3.07		1.76		2.53		5.71	
Recent	100.00	74.39		12.38		0		3.07		1.92		2.53		5.71	

1/ Benefited areas include acres receiving benefits from flood protection and/or drainage; they exclude areas for which erosion benefits are expected. Nonbenefited and upland areas include all remaining areas.

Appendix table 16--Net land use changes on uplands of completed and new projects, Southeast region 1/

Land use	Early share 2/		Late share 2/		Change	
	Completed	New	Completed	New	Completed	New
	Percent of upland area 3/					
Cropland	20.56	15.52	14.80	12.12	-5.76	-3.40
Grassland	18.17	12.42	17.92	12.16	- .25	- .26
Idle-transition	10.17	34.43	10.64	34.06	- .06	- .37
Forest	38.90	28.28	43.11	30.33	+4.21	+2.05
Urban	3.55	3.07	5.05	4.49	+1.50	+1.42
Rural-urban	2.11	1.79	2.11	1.79	0	0
Reservoirs	0	0	.36	.56	+ .36	+ .56
Miscellaneous	6.02	4.49	6.02	4.49	0	0
Total	100.00	100.00	100.00	100.00	0	0

1/ The change interval averaged 14. 2 years for completed and 15.2 years for new projects.

2/ Early photo dates averaged 1955 for completed and 1954 for new projects. Late photos averaged 1969+ for both completed and new projects.

3/ Upland included 94.5 percent of completed and 95.9 percent of new projects; upland included all land not benefited.

Appendix table 17--Net land use changes on benefited areas of completed and new projects, Southeast region 1/

Land use	Early share 2/		Late share		Change	
	Completed	New	Completed	New	Completed	New
	Percent of benefited area 3/					
Cropland	17.44	23.59	16.38	22.94	-1.06	-.65
Grassland	20.19	4.77	20.19	4.77	0	0
Idle-transition	18.29	44.31	18.29	44.31	0	0
Forest	38.56	15.78	39.62	16.43	+1.06	+.65
Urban	.89	0	.89	0	0	0
Rural-urban	0	.09	0	.09	0	0
Miscellaneous	4.63	11.46	4.63	11.46	0	0
Total	100.00	100.00	100.00	100.00	0	0

1/ The change interval averaged 14.2 years for completed and 15.2 years for new projects.

2/ Early photo dates averaged 1955 for completed and 1954 for new projects. Late photos averaged 1969+ for both completed and new projects.

3/ Benefited area accounted for 5.5 percent of completed and 4.1 percent of new projects.

Appendix table 18--Land uses on nonbenefited areas of completed and new projects, Delta region, about 1957

Land use	Completed projects		New projects 1/		
	Total (8) 2/	Ark. (7)	Total (6)	Ark. (3)	La. (3)
	Percent of nonbenefited area				
Cropland	28.81	61.52	29.75	37.17	24.32
Grassland and idle-transition	13.19	13.34	10.71	22.03	2.41
Forest	47.10	11.61	40.63	33.71	45.71
Urban	3.59	4.59	10.74	.21	18.45
Rural-urban and miscellaneous	7.31	8.94	8.18	6.88	9.11
	Percent of total project area				
Nonbenefited area	43.6	27.6	23.0	47.8	16.7

1/ There was no nonbenefited area on 1 Mississippi, 1 Arkansas, and 2 Louisiana projects.

2/ Includes 7 in Arkansas, 1 in Louisiana. On the other 2, all land was benefited.

Appendix table 19--Land uses on benefited areas of completed and new projects, Delta region, about 1957

Land use	Completed projects		New projects		
	Total (10)	Ark. (8)	Total (10)	Ark.-Miss. (5)	La. (5)
	Percent of benefited area				
Cropland	51.71	49.60	37.15	60.72	33.38
Grassland and idle-transition	6.31	6.45	4.81	6.37	4.56
Forest	31.41	33.57	49.08	19.70	53.79
Urban	2.32	2.51	1.09	.54	1.18
Rural-urban and miscellaneous	8.23	7.87	7.87	12.67	7.09
	Percent of total project area				
Benefited area	56.4	72.4	77.0	52.2	83.3

Appendix table 20--Annual rates of net land use change on nonbenefited areas of completed and new projects, Delta region, about 1957-70 1/

Land use	Completed projects		New projects 2/		
	Total (8) 3/	Ark. (7)	Total (6)	Ark. (3)	La. (3)
	Percent of nonbenefited area				
Cropland	+.22	+.17	-.32	-.92	4/ +.11
Grassland, idle-transition	-.02	-.04	+.34	+.81	0
Forest	-.30	-.25	-.17	-.11	-.22
Urban	+.08	+.08	+.09	+.06	+.11
Rural-urban miscellaneous	+.02	+.04	+.06	+.15	0

1/ Rate of change is calculated by dividing the average change for the interval between photos by 12.7 years.

2/ There was no nonbenefited area on 1 Mississippi, 1 Arkansas, and 2 Louisiana projects.

3/ Includes 7 in Arkansas and 1 in Louisiana. On the other 2, all land benefited.

4/ Net result of converting 1,197 acres of cropland to urban use on 1 project, and adding 3,256 acres of new cropland on the other 2.

Appendix table 21--Annual rates of net land use change on benefited areas of completed and new projects, Delta region, about 1957-70 1/

Land use	Completed projects		New projects		
	Total (10)	Ark. (8)	Total (10)	Ark.-Miss. (5)	La. (5)
	Percent of benefited areas				
Cropland	+1.55	+1.83	+1.64	+.53	+1.81
Grassland, idle-transition	--	--	--		-.01
Forest	-1.56	-1.84	-1.68	-.53	-1.84
Urban	+.01	+.01	+.04	--	+.04
Rural-urban miscellaneous	--	--	--	--	--

-- = less than .005 percent

1/ Rate of change is calculated by dividing the average change for the interval between photos by 12.7 years.

Appendix table 22--Net land use changes on upland areas of completed and new projects, Missouri River tributaries region 1/

Land use	Early share		Late share		Change	
	Completed	New	Completed	New	Completed	New
	Percent of benefited area 3/					
Cropland	70.9	77.6	70.5	77.3	-.4	-.3
Grassland	16.4	9.9	16.1	9.8	-.3	-.1
Idle-transition	.2	--	.2	--	0	0
Forest	2.7	1.7	2.5	1.4	-.2	-.3
Urban	2.1	2.6	2.5	2.8	+.4	+.2
Rural-urban	3.4	3.8	3.4	3.8	0	0
Reservoirs 4/	0	0	.4	.5	+.4	+.5
Miscellaneous	4.3	4.4	4.4	4.4	+.1	0
Total	100.0	100.0	100.0	100.0	0	0

-- = less than .05 percent.

1/ The change intervals for the two groups were 14.7 years for completed and 13.8 years for new projects.

2/ Early photo dates averaged 1955 for completed and 1956 for new projects. Late photos averaged 1970 for both groups.

3/ The upland areas constituted 93.05 percent of completed projects and 94.38 percent of new project areas.

4/ Permanent water areas only; areas tabulated as reservoirs on new projects were not visible on photos, but were derived from project plans in order to provide comparisons with completed projects.

Appendix table 23--Net land use changes on bottomland areas of completed and new projects, Missouri River tributaries region 1/

Land use	Early share 2/		Late share 2/		Change	
	Completed	New	Completed	New	Completed	New
	Percent of bottomland area 3/					
Cropland	59.5	74.5	60.2	74.4	+.7	-.1
Grassland	22.3	12.4	22.3	12.4	0	0
Idle-transition	0	0	0	0	0	0
Forest	12.2	3.1	11.5	3.1	-.7	0
Urban	.9	1.8	.9	1.9	0	+.1
Rural-urban	.8	2.5	.8	2.5	0	0
Miscellaneous	4.3	5.7	4.3	5.7	0	0
Total	100.0	100.0	100.0	100.0	0	0

1/ The change intervals for the two groups were 14.7 years for completed and 13.8 years for new projects.

2/ Early photo dates averaged 1955 for completed and 1956 for new projects. Late photos averaged 1970 for both groups.

3/ Bottomlands are areas expected to benefit from flood damage reduction and/or drainage. They constitute 6.95 percent of completed projects and 5.62 percent of new projects. Three completed projects had no benefited bottomland.